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The Gearless Motor. ELSEWHERE in this issue will be found a description of an improved form of gearless motor which the Short Electric Railway Company has just brought out. While there are quite radical changes in many of its features, perhaps the most important are the reduction in weight to 2,300 lbs. and the greater compactness of design, which now permits it to be placed on 30-in. wheels, points which have a bearing on its application to street railway service. The gearless motor has won its place in traction work and its field is constantly enlarging. In every case where it has been proposed to replace the steam locomotive by the electric motor, as for instance in the Baltimore tunnel, the gearless type has been the only one considered, and this field alone offers sufficient attractions, even if the gearless motor should never be able to displace its rivals in ordinary street car work.

Multiphase Transmission in America. WHILE American engineers have heretofore designed all transmission of power plants for direct current generators and motors, or in a few notable instances for alternating machines of the synchronous type, they have not been slow to see certain advantages possessed by the multiphase system for long distance transmission. We are informed that a plant, located in New England, is to be installed this month using a multiphase generator and motor, each of 300 h. p. capacity, to transmit power from a waterfall to a lighting station eleven and a half miles distant. The motor will there be utilized to drive dynamos that supply current for street lighting. Such service would be an ideal one for driving railway generators owing to the steadiness of running, and the fact that the violent fluctuations of load that are such a prominent feature of railway operation produce an inappreciable effect on the speed of multiphase motors.

A New Type of Westinghouse Generator. IN our columns this week will be found a description and illustration of a new type of Westinghouse generator now in process of erection in the station of the Narragansett Electric Lighting Company, at Providence, R. I., where it will be ready for operation in a few days. The construction is going on side by side with the work on a generator of the same capacity—about 5,000 lights of 16-c. p.—that the General Electric Company is building in the same station, as was announced in our columns two weeks ago. The peculiarity of the Westinghouse construction, well shown in our illustration, is the method of building up the armature coils upon the rim of the engine flywheel, or, more accurately, upon a frame that is attached to the periphery of the wheel. The field coil frame, as shown in our drawing, is movable along sliding ways in a direction parallel to the axis of the armature to facilitate necessary repairs on the armature coils. The speed of the machine is, of course, that of the engine, and is very low compared with that of existing types of Westinghouse alternators. As is the case with the General Electric Company's machine, this generator is driven by a slow speed horizontal compound engine. The report of the performance of the two machines will be awaited with interest.

Electric Traction on Steam Roads. THE rapid growth of the electric railway is perhaps the best indication that has been furnished of the readiness with which capitalists take hold of any new method of operation which promises after careful and satisfactory trials to cheapen the cost of operation and add to the dividends on the capital invested. What has been true in the case of street railways will, without doubt, be repeated in the case of steam roads when the actual operation of such roads by electricity can be demonstrated to their managers to be less expensive than present methods of operation. A significant paragraph occurs in the annual report of President Clark to the board of directors of the New York, New Haven & Hartford Railroad, which was submitted last week to the stockholders of that road. President Clark says: "If electricity as a motive power becomes commercially practicable, the two interior tracks of the four now in process of construction between New York and New Haven, with their improved grades and alignments and absolute freedom from grade crossings, will prove especially adapted for its use." While President Clark does not in any way commit himself to advocating the adoption of electricity, it is certain that the above quotation expresses his willingness to give electricity a trial as soon as he can be convinced that this method of operation would prove more economical as well as more satisfactory to the patrons.

Electricity and the Art of War. IN the current number of the *Journal of the United States Artillery*, First Lieutenant C. D. Parkhurst, of the Fourth Artillery, writes of the applications of electricity to warfare. Owing to the comprehensive character of the paper, much space is taken up with the obvious applications of electricity, as the telegraph, search light, in firing mines, etc., but an important suggestion is made in connection with the former, to the effect that, owing to the vital importance of the telegraph in time of war to the government, in war time the employés should be under governmental control and regularly enrolled in the military service. The writer refers to the extensive field for electricity in forts, and in the discussion it appears that this has been recognized in the plans for reconstructing our fortifications. Electricity is the ideal power for fortifications, and it is surprising that it has received such tardy recognition. From a well protected central station power can be transmitted through underground conductors to a network of conductors within the more exposed parts, and thus insure infinitely more reliability than by any other means. All the various operations in training the guns and handling the ammunition can best be done through motors, and the system could be tapped anywhere for current for search lights, firing mines, signals, etc. Independent of these important applications the value of electricity as an illuminant alone in magazines and casemates should render its use indispensable in forts. The day does not seem far distant when we shall see every operation in a fort requiring power performed by electricity, and with officers like Lieut. Parkhurst to design and superintend the plants their technical thoroughness will be assured, and the general public thus furnished with object lessons that will create a tendency to extend power applications.

Commercial Efficiency of Transformers. M. PICOU, in the columns of a French contemporary, reviews the commercial efficiency of transformers, taking as a text the comparative merits of the "hedgehog" and the Dobrowolsky types. As our readers will remember, these two types were designed to decrease the iron loss, which is constant, at the expense of the copper loss, which varies as the square of the current, the proportions being such, however, that there is a resultant gain in all-day transformer efficiency. This entails disadvantages in both types, but a notable one in the latter—a great deficiency in regulation. To examine the commercial bearing of this point, M. Picou considers three methods of applying transformers—in substations, in feeding street secondaries, and one to each customer. In the first case, owing to the possibility of working always at the highest efficiency, the ordinary type is pronounced the best. The second case furnishes a field for non-regulating transformers, as the regulation can be controlled from the station. In the latter case, however, self regulation is the controlling factor, efficiency in comparison not entering at all. To quote M. Picou: "One can easily conceive of a station retaining customers if the price of light should be doubled, where not one would be retained with a variation of eight per cent. in the transformer." Owing to the fact that almost all lighting is done through individual transformers M. Picou concludes that the all-day high efficiency has no value if not coupled with self regulation. M. Picou further calls attention to the necessity of considering all the commercial factors in deciding the efficiency of any apparatus or combination, even those that result from ignorance or conservatism; a type of the latter is the distrust of complications in spite of high efficiency to which a figure should be assigned in the calculation of commercial efficiency. Inventors are too apt to lose sight of these considerations, and by failing to make good their comprehensive claims they discredit the real merits of their invention.

Effects of the Lamp Patent Decision. THE broad decision which was handed down last week in the U. S. Circuit Court of Appeals, the full text of which was given in THE ELECTRICAL WORLD of last week, has excited a widespread interest on the part of the general public, whose interest is that of the consumer, as well as among the manufacturers of incandescent lamps, whose product is supposed to be an infringement on the patent over which litigation has been so long pending. Some opinions of those interested, financially and otherwise, in the future of the lamp business, are given elsewhere in our columns. The consumer will, we are sure, be pleased with the assurance that comes from a high official of the General Electric Company that there is not the slightest intention on the part of the company which he represents to take any steps that will directly or indirectly increase the cost of the incandescent lamp to the consumer, but that, on the other hand, it will ultimately reduce the retail price. As to the intended action of the company toward the other lamp manufacturers the same gentleman assures us that no such short-sighted policy as "freezing out" the smaller companies now infringing the fundamental patent is contemplated. While as yet no official action has been taken by the company's officials, it is asserted that all infringing manufacturers will probably be allowed to continue the manufacture of lamps by the payment of a reasonable royalty. The wisdom of this policy cannot be doubted. The present plant of the General Electric Company would, if other factories were enjoined from manufacture, be unable to supply the demands of consumers of incandescent lamps; and it is an open question whether it would be a paying investment to increase its facilities to the extent necessary when the short time that it would be able to control the monopoly is taken into consideration. This policy will give the smaller manufacturers increased assurance in the stability of their business, and will undoubtedly have the effect of stimulating the production both of the existing plants and of new factories that will doubtless now be established. The attitude of the Westinghouse company toward the decision is somewhat different from that of other companies, owing to the fact that it will, according to the statements of Mr. Westinghouse as given in the announcement of the Westinghouse company on page xvii. of this issue of THE ELECTRICAL WORLD—immediately take up the manufacture of a new form of lamp which it is claimed does not infringe on the patent that has just been upheld in the Court of Appeals. An early official announcement of the policy of the General Electric Company is expected,

The Effect of the Filament Decision.

An obstruction when it becomes serious enough is sometimes sufficient to divert a river from the course it for years has followed. In like manner the difficulty of obtaining building sites at what is considered a reasonable price, or some similar cause, has often arrested the development of a city in a particular direction and changed its whole future.

If the expectations of the Westinghouse company, as expressed in the announcement it makes in its advertisement on page xvii. of this issue, are fully realized, one effect of the recent decision upholding Mr. Edison's claim to the present form of incandescent lamp may be the introduction of a lamp differing in principle from that to which we have heretofore been accustomed.

President Westinghouse and Vice-President Bannister personally assure THE ELECTRICAL WORLD that in their opinion the decision of last week will not occasion the Westinghouse company any serious embarrassment in its business. They propose to continue the manufacture of incandescent lamps to even a greater extent than heretofore, but these lamps, they claim, will not infringe the Edison or any other patent, while they are covered by patents owned by the Westinghouse company. As stated by Mr. Westinghouse on page xvii. of this issue, the lamp differs radically from those now in use. It requires no platinum and is made in separable parts, any one of which may be renewed, the others being used over and over again, which it is thought will effect a saving to the consumer of from 30 to 50 per cent. in the cost of incandescent lamps.

In reply to THE ELECTRICAL WORLD'S inquiry as to what action would be taken by the General Electric Company as a result of the recent decision, Captain Eugene Griffin, vice-president and general manager, said that so many different questions are involved that it is impossible as yet to say just what will be done in the matter. The company, however, does not contemplate any dog-in-the-manger policy. While the officers of the company think that the General Electric might be able, by increasing its facilities, to supply the entire demand in this country for incandescent lamps, it is likely that manufacturers in different sections of the United States will be licensed to make the lamps on royalty.

The case of each manufacturer will probably be taken up separately and an amicable arrangement arrived at if possible. The users of incandescent lamps infringing the Edison patent being liable equally with the manufacturers, the same effort at amicable adjustment will also be pursued with regard to them, and it is thought that no very serious difficulty will be experienced in arriving at an equitable settlement in most of the cases.

Under no circumstances is it the intention of the company that the price of incandescent lamps shall be increased. On the contrary, a reduction may be expected before very long.

History tells us that revolutions occur, not at times of commercial depression, but during or following periods of unusual prosperity. Great labor disturbances follow the same rule. Litigation also seems to be most often resorted to where business is active, though such friction usually has the effect of retarding the progress of both the parties to it. A recent visit to the works of the Westinghouse Electric and Manufacturing Company at Pittsburgh—one of the litigants in the lamp case—showed that the immense facilities of the company are being taxed to the very utmost to even approximately keep up with the orders constantly pouring in. Not far from 2,000 men are now on the payroll, and the business alone is larger than it ever previously has been in the history of the company. The air of prosperity about the office and the various works of the General Electric Company also—the other litigant—is equally as unmistakable. The disciples of Coke and Blackstone would probably think they were being harshly treated if they were not allowed to share a little in the prosperity of the electrical business.

Opinions Regarding the Edison Lamp Decision.

In the last issue of THE ELECTRICAL WORLD we gave our readers the full text of the important decision in the United States Circuit Court of Appeals on the Edison lamp patent. This decision has occasioned widespread interest among financiers and electricians, and has given rise to a certain amount of uneasiness on the part of the general public, whose interest is due to a feeling that the price of lamps to the consumer may be advanced, as well as on the part of the half score or more of lamp manufacturers now doing a successful business in supplying an excellent grade of lamps and whose daily output of lamps aggregates probably over 40 per cent. of the entire product now on the American market. To ascertain whether there was good ground for this uneasiness we have endeavored to obtain the opinions of those most concerned in the matter. These opinions indicate a state of affairs that is certainly encouraging, both for the manufacturer and the public. An official of the General Electric Company, who has had and still has a large share in the shaping of its policy, gives us the emphatic assurance that there is not the slightest intention on the part of that company to increase the price of lamps to the consumer. That is above all others the one thing, he says, which they will not do. The policy toward the manufacturers will be equally fair. No factory now turning out lamps will be forced out of business provided its proprietors are willing to pay a fair and legitimate royalty to the owners of the successful Edison patent. The lamp business, in other words, will remain as before, except that the companies infringing the Edison patent will be required to pay a small royalty, but will, upon such payment, be permitted to continue in the manufacture of lamps as at present.

The position of the Westinghouse company, the largest manufacturer of lamps to be affected by the decision, is fully set forth in the following circular which Mr. Westinghouse issued on Saturday last:

To users of incandescent electric lamps:

In order that no one may be misled by the statements of the owners of the Edison patents with regard to the effect of the recent decision of the United States Circuit Court of Appeals for the Southern District of New York, sustaining the second claim of Mr. Edison's incandescent lamp patent (the other three claims having been held by the court not to be infringed), we beg to announce to our customers and to users of incandescent electric lamps generally that we are prepared to receive orders for the delivery in quantities after Dec. 1 of our new incandescent lamps, the manufacture of which has been established at our Pittsburgh factory.

These lamps not only do not infringe the Edison patent above referred to nor any of the patents of other companies, but they are fully covered by patents of our own.

The new lamp differs radically from those now in use. It requires no platinum and is made in separable parts, so that the incandescent burner can be renewed and the bulb and other parts of the lamp used over and over. Furthermore, by means of an important discovery, the burner is rendered stable, its efficiency increased, its life prolonged, and its normal candle power maintained.

The manufacture of these lamps will be carried on almost entirely by machinery, and the first cost thereby considerably reduced, so that with the advantages obtained from the re-use of the bulbs, a saving of from 30 to 50 per cent. to consumers in the cost of incandescent lamps for a given service will be effected.

These lamps are in appearance a decided improvement over those now in use, and when used with a new socket designed for the purpose a further reduction in the cost of lamp renewals will be effected, as no base attachment is required to make the connection with the socket.

We are prepared to make advantageous time contracts with the users of incandescent lamps, with important allowances for the return of the bulbs to our factory.

At the offices of the Westinghouse people we obtained a reiteration of the statement made by Mr. George Westinghouse, Jr., in the above circular, to the effect that the decision would not in the slightest manner affect the business or revenue of the Westinghouse Company. The manufacture of incandescent lamps, it is said, is only 5 per cent. of its volume of business. The patent protected by the decision is on one little device. "The world is large and the decision is not going to affect it in the least."

General Duncan, of Duncan & Page, consulting attorneys of the Westinghouse company, informs THE ELECTRICAL WORLD that the recent decision will have little or no effect upon the United States or the Westinghouse company. He intimated that the Westinghouse company expected an affirmation of the lower courts, and has been preparing itself since that decision to meet any contingencies which might arise.

In regard to the statement to the effect that the Edison company will receive immense benefits from the decision, he is very much inclined to be skeptical. He says that a logical conclusion is that if the Edison company is the gainer to any material extent some one would have to be the loser. Just who that some one was in this case he failed to see. The Westinghouse company acknowledges that it has lost the patent, but also claims that there is no profit in that department of the business. General Duncan said further that certain very prominent stockholders of the Westinghouse company made the statement some time before the decision was rendered that they "hoped it would be adverse to the company."

Concerning the stories in circulation to the effect that the accounting which the Westinghouse people will be compelled to make by the decision will involve enormous sums, General Duncan said that this accounting had been going on before a Master since the decision in the lower court. Considerable testimony has been taken on both sides, but up to date none has been submitted which will show that the Westinghouse is in any way liable to the Edison company for damages. In order to prove the liability, the Edison company would have to show that Westinghouse injured its business, and also that it derived profits.

Treasurer Kobbe, of the Westinghouse company, says that the officials of that company are of the opinion that no great sum of money will ever be adjudicated as payable by the outside companies to the Edison company as royalties for infringement of the incandescent lamp patent. The Westinghouse company had long since anticipated the probability of such a decision, and had invented and perfected a new filament by which 50 per cent. is saved in the manufacture of incandescent lighting apparatus. The manufacture of this lamp will be begun immediately.

Mr. Lewis, of Eaton & Lewis, Edison attorneys, is quoted by a daily contemporary as saying that from 50,000 to 80,000 lamps were used daily. Of these the Edison company had been making 40 per cent. The price would not be advanced, and customers of the United States company would not be interfered with. It was likely that an arrangement would be entered into by which other companies would be allowed to continue the manufacture of lamps, as the Edison company had not sufficient capacity to manufacture all the lamps required.

Another publication quotes the attorneys of the Edison company as saying that the decision is worth nearly $2,000,000 to the General Electric Company. The right to manufacture incandescent lamps during the six years which the patent has to run is worth so much money that the attorneys hesitate to make an estimate.

Dow, Jones Co. publish the following: "The importance of yesterday's decision has been underestimated by the public," said a prominent electrician last night. "They do not understand what the monopoly of the incandescent light means. All over the country there are electric plants using these lights and all are liable for past damages and must pay future royalties. Allowing that this decision does not increase business, which is of course rank nonsense, the General Electric Company is doing a wonderful business. Its August net earnings exceeded $500,000 and in 25 days in September were nearly $500,000. It is earning at the rate of over $6,000,000 per annum net. In addition to this it has received so far in the fiscal year $2,500,000 stocks of subordinate companies and $1,900,000 in bonds of the same companies As the American Bell Telephone Company prospered through its subordinate companies, so will the General Electric grow. Its capital is small, and this decision will force all of its competitors into amicable arrangements, which will be profitable in a high degree to the company."

Woerishoffer & Co., leading stock brokers, say: "The incandescent lamp decision is of vast importance, and of great money value to the General Electric Company and its licensees. . . . We should not be surprised to see General Electric sell up to 150."

Exhibits at the American Street Railway Convention.

The Short Electric Railway Company is preparing for quite an elaborate exhibit at Cleveland, which will show the principal types of its apparatus in actual operation, including the following: One 20-h. p. six-pole gearless motor; one 20-h. p. single reduction motor; one 30-h. p. single reduction motor; one 66-h. p. slow speed railway generator; station and car appliances complete; the new multiple series switch.

The following car bodies and trucks, all equipped with the Short motors, will also be in daily service: One car body of the Brownell Car Company equipped with the Brownell truck; one of the St. Louis Car Company with St. Louis truck; one of the Lamokin Car Company with Robinson radial truck, one of the Gilbert Car Company with Anger truck; one Short private car with Anger truck; one Short gearless car with Short truck; one single reduction car with Short truck.

The Swan Lamp Manufacturing Company, of Cleveland, O., will make a very complete exhibit at the convention, showing not only its well-known street railway lamp, but also several novelties in the way of lamps for general commercial use and for decorative purposes.

The New Short Gearless Motor.

One of the most interesting exhibits at the National Street Railway Convention at Cleveland, O., will undoubtedly be the new gearless motor which Prof. Short has recently designed. This new motor, while resembling its predecessors in the more salient points, has been much improved and some things which might have been considered as defects have been removed.

In all branches of mechanics the machine of the fewest parts and simplest form, which will accomplish the desired result, is the best. In no case is this more true than with the street car motor, which is placed under the most unfavorable circumstances and called upon to do the hardest kind of work.

To-day it is running in clouds of dust which tend to grind and wear its running parts; tomorrow it is splashing through mud and water which continually tend to impair its insulation. It is under the car where it is difficult to get at, and is therefore never clean; and it is handled by unskilled labor and allowed to run until it refuses to work longer. The railway motor, like a locomotive, is a public servant; like the locomotive it must always be ready for duty. One familiar with the evolution of the railway locomotive knows that the tendency has constantly been to simplify the structure and secure a mechanism of few parts. The original locomotives were arranged with high speed engines, geared down to the slow speed of the axle of the locomotive truck. This was soon abandoned as impracticable because of the wear and tear on the many parts. It will also be remembered that for the direct coupling of the cylinders of the locomotive to the driving wheel a valve gear pumping arrangement and many devices were necessary. These were cast aside finally, and our modern locomotive is an exceedingly simple machine.

The same evolution is taking place in street car motors. The original form of motor for this purpose was what was known as the double reduction gear motor, in which the power of the high speed armature was sent through a train of gears to the driving axle of the car. Those motors are to-day but little used. The wearing parts being so many the cost of repairs became a very serious matter. Within the last year all of the electric companies have largely decreased this cost by placing upon the market a single reduction gear motor.

Aside from the cost of repairs in geared motors one of the objections to the use of motor cars on residence streets is the noise. Spur gears wherever run, even under the most favorable conditions, are more or less noisy, but under the unfavorable condition of street traffic the noise often becomes such that the property holder objects to the motor car passing his residence.

But without the use of gears it is claimed that a perfectly noiseless motor is obtained. There is no reason why a motor car should not be made to run as smoothly and quietly as an ordinary horse car. By the use of a gearless motor for the propulsion of street cars the following wearing parts of the double reduction motor are avoided: Two high speed shafts, two pinions, two gears, four brass bearings,

four oil cups, four bearing caps, sixteen cap bolts, motor pans, side curtains, and all the attending fixtures, bolts, nuts, etc., that go to fasten these things in place, while about half of these parts are saved when comparison is made with the single reduction motor.

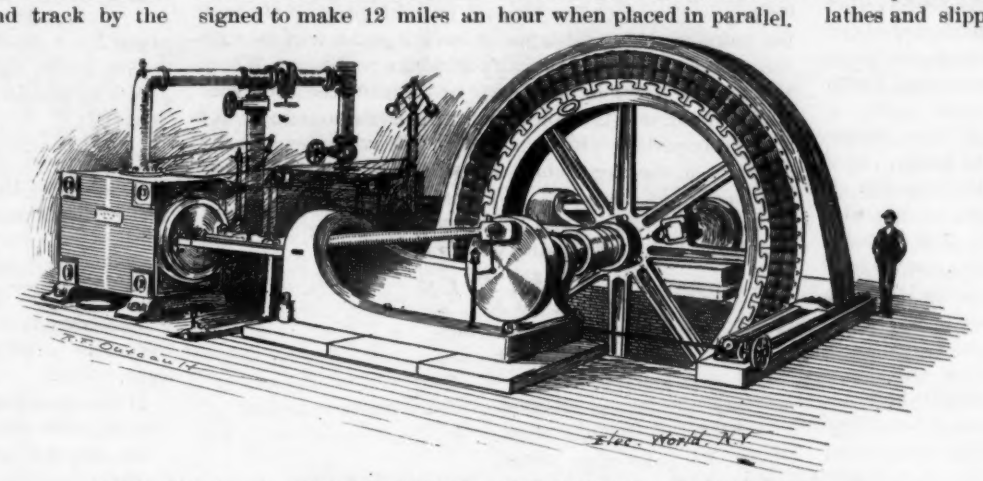
The gearless motor also has the advantage of spring suspension. In all geared motors one end of the motor must be journaled to the axle, the other is supported by springs. One-half the weight is carried directly on the axle of the car and only one-half is cushioned, while the entire weight of the gearless motor is supported on spiral springs and it rides as easily as the car body. Therefore no such hammer blow is communicated to the wheels and track by the weight of the motor as in the former case, and the track joints are spared the hammering which they receive from geared motors.

The efficiency of the gearless motor is a disputed point. Its advocates claim that it returns at the car wheels from 15 per cent. to 20 per cent. more power than the geared type, owing to the decreased friction loss in the bearings on account of the slow speed of the armature, less loss in the armature from Foucault currents, hysteresis and eddy currents and the absence of all loss in transmitting gears.

The Short company has undertaken the development of this machine, and has expended a large amount of money and time in its perfection. The first type of this motor was exhibited a year ago at Pittsburgh. This motor, a four-pole machine having an armature 24 inches in diameter, gave excellent satisfaction. The armature was of the Paccinotti type, with the field magnets, eight in number, presented on either side, and the whole encased in a cast iron frame and provided with a hollow shaft through which the axle of the car played freely in a flexible driving clutch. The car at the convention was provided with two of these motors, each having a capacity of 20 h. p. It was necessary to mount these motors on 36-inch wheels owing to the size of the armature ring. A number of these motors were manufactured and shipped to various places, and they have now been in operation about a year, giving the best satisfaction with a nominal cost of repairs.

This motor, however, was not satisfactory to the Short company, owing to its size and weight, and the cost of manufacture. A second design embodying the same principles but arranged so that the field magnets were presented to the face of the armature ring has been brought out within the year and a number manufactured and sold with excellent results. These motors were adapted to 33-in. wheels, and the efficiency of the machine was increased. These machines weighed 3,000 lbs., and the excessive weight and cost of production were still in the way of their manufacture for commercial purposes. Within the last three months, however, the Short company has placed upon the market an entirely new type of gearless motor arrange for 30-in. wheels, and weighing only 2,300 lbs., the efficiency of which is still higher, and which they believe will fulfill all the requirements of street railway practice, except where exceedingly low speed is required. This motor is triangular in shape, and has 13 field magnet cores cast integrally with the frame and three consequent pole pieces, making a six pole machine of a peculiar form. The frame is cast of the softest steel and every pound of material in it is utilized in the magnetic circuit; hence the small weight. The armature is iron-clad, the wire being sunk into the metal so that it is protected magnetically. The commutator is large and has an ample carrying capacity. But two brushes are used, which are of carbon. The machine is entirely waterproof, and the copper on both armature and field magnets has an extremely large carrying capacity and therefore the heating due to the wire resistance is small. The machine is so carefully constructed that its friction and hysteresis losses are reduced to a minimum, and it shows its excellent design from the fact that its efficiency reaches, it is claimed, nearly 90 per cent. at one part of its load, and over 75 per cent. at full load. Two of these motors placed on a car, together with a multiple series controlling switch, will give the most satisfactory results from a practical standpoint. When placed in series these motors will make about ten (10) miles an hour, with ordinary loads on level track, while in parallel they will make about 20 miles an hour. At full load these motors are designed to make 12 miles an hour when placed in parallel. The machine now ready for the market has a capacity of from 20 h. p. to 25 h. p., but motors of larger size are being designed especially with reference to suburban traffic on interurban lines where high speed is to be attained and trains of cars are to be pulled.

As a matter of interest and in order to show more clearly the history of the development of the gearless motor, we present herewith three curves of efficiency and horse power; the first one being for the 24-inch gearless motor, which was exhibited at the Street Railway Convention in Pittsburgh; the second one for the 33-inch gearless motor, which was designed immediately afterward, and the third for the six-pole gearless motor, which is to be on exhibition at the convention in Cleveland.



NEW 500-H. P. WESTINGHOUSE GENERATOR, PROVIDENCE, R. I.

Direct Coupled Five-Hundred Horse Power Generator of the Narragansett Electric Lighting Company.

In the station of the Narragansett Electric Lighting Company, of Providence, R. I., there are in the process of erection two dynamos which possess peculiar interest both on account of their size and from the fact that they are quite a radical departure, in some respects, from any of the types in use at the present day. One is being constructed by the General Electric Company and the other by the Westinghouse Electric and Manufacturing Company. These generators each have a capacity of 500 h. p. and are direct driven at 90 revolutions per minute by a cross-compound automatic cut-off steam engine of special design, built by the E. P. Allis Company, of Milwaukee, Wis. These engines are alike in size; the high-pressure cylinders are 19 inches in diameter, and the low-pressure cylinders 36 inches, with a stroke of 48 inches. The cylinders are steam jacketed.

The two engines are located in the western portion of the engine house and rest on a foundation about 50 feet square. This area was excavated to a depth of eight feet below datum or high water line, and is inclosed by sheet piling. Piles were driven over the bottom surface to depths varying from 30 to 20 feet. On top of these rests a bed of concrete 30 inches thick; this, after being leveled off, formed the base on which the engine foundations proper, of brick laid in cement, were laid, the same extending some six feet above the base line. Large granite stones were bedded into the brickwork where required, the top stones being faced off to receive the engines.

The Westinghouse generator is nearly completed and it will soon be in operation. A correct idea of its construction may be obtained from the accompanying illustration. The idea of the direct coupled engine and dynamo is by no means new, and units in which the armature replaces the flywheel have recently been constructed; but in this case the armature is actually built upon the original flywheel of the engine. It can be seen from the cut how the armature is built up. The number of coils is 80, which are wound on lathes and slipped into place. The cores are made up of thin plates of special iron, some 60,000 of these plates being used in the construction of the armature and field. A device is provided for moving the field to one side away from the armature so as to give free access to all parts of both.

The current is taken off by large brushes from ring collectors upon the shaft. The field is excited partly by a separate machine and partly by a current from the dynamo itself. The number of alternations is 120 per second. This generator is guaranteed to deliver 373,000 watts, with a maximum rise in temperature not exceeding 54 degrees Fahr. above the surrounding air. An efficiency of 92 per cent. is guaranteed, but it is expected that the actual commercial efficiency will be about 94 per cent.

The following dimensions give some idea of the size of this machine: The foundation space occupied is 42 feet by 21 feet 6 inches. The outside diameter of the field is 19 feet 7¾ inches, while the diameter of the flywheel is 16 feet. The weight of the armature and of the field complete will approximate 90,000 pounds.

Our illustration is re-drawn from a cut in a recent issue of the *Providence Journal*.

Electric Heating and Cooking.

This interesting industry has recently made very rapid development under the auspices of the Carpenter Electric Heating Manufacturing Company, of St. Paul, Minn. The idea is to conduct the current direct to the parts requiring heat so that comparatively no energy is lost by radiation. As an illustration of the practical application of this, take the electric flatiron. The flatiron surface is put through a process which extracts from the metal all impurities and there is then spread over it an enamel substance, the composition of which is a secret, and in this is laid plain iron wire zig-zagged over the whole surface with the two ends extended half an inch apart up to within an inch of the rear edge of the surface. Copper wire is laid on the soft enamel from the rear edge up to and connecting with each end of the iron wire and then more enamel is spread over the surface completely covering all the wire. The copper wires are connected with the source of electricity. The iron wire having a comparatively high resistance and small radiating surface plays the same part that the filament in an incadescent lamp does and consequently a large amount of heat is generated.

The heat in the enamel can be easily regulated to any desired degree. The enamel can be applied in the same way to the excited surface of pots, kettles, spiders or other cooking utensils. The articles consume from one-half an ampère to ten ampères, according to their requirements, and on account of the concentration of the heat at the very point where it is needed food can be cooked in a very few minutes. Although this method might seem expensive, on account of its high efficiency it is comparatively economical, while it possesses a convenience and flexibility that highly recommend it.

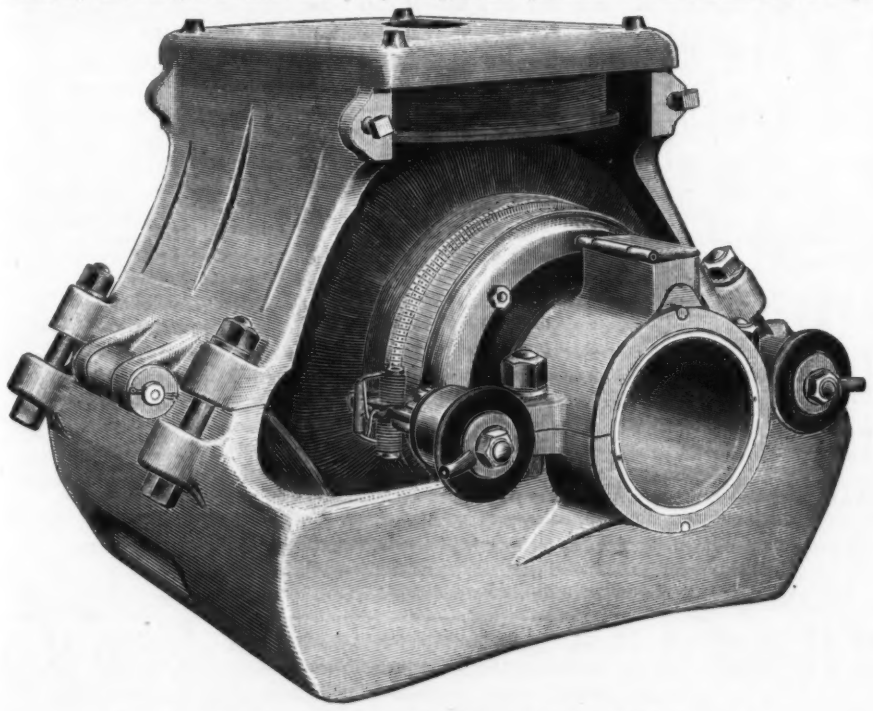


FIG. 1.—THE SHORT GEARLESS MOTOR.

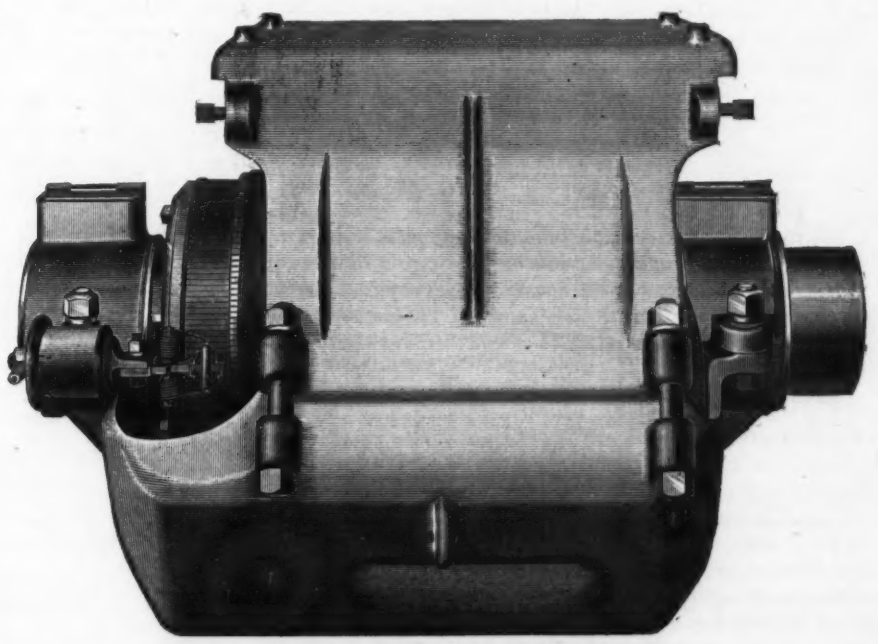


FIG. 2.—THE SHORT GEARLESS MOTOR.

Rules, Formulae and Tables for Incandescent Wiring.*

BY W. D. WEAVER.

The most accurate method of determining the proper sizes of incandescent lamp conductors is to refer *all* measurements back to the dynamo, converter, or street tap.

To illustrate, suppose we have an installation of 150 lights, consisting of a feeder or dynamo main 20 feet long (to distributing point) and several mains *A*, *B* and *C*, their lamps and lamp centres being respectively 60, 50 and 40 in number, and 38, 60 and 90 feet from the end of the feeder. Let us calculate the size of the feeder and one main, and of one branch having 12 lamps with centre 20 feet from the main, the branch starting 18 feet from the distributing point. (See cut.)

To find the size of the branch wire, refer to a wiring table with 20 + 18 + 20 feet, or 58 feet for 12 lamps.

To find the size of the main, imagine the branches on one side to be revolved (or lay them out thus on a diagram) so that *all are on the same side of the main;* then estimate or calculate the lamp centre of the resultant group, which in this case we will suppose to be 23 feet from the main and 38 feet from the distributing point measured along the main, and refer to the table with 20 + 38 + 23 feet for 12 + 30 + 18 lamps, or 81 feet for 60 lamps.

To find the size of the feeder, suppose the mains to be revolved about the distributing point so that they all overlap, and with all the branches on one side of the overlapping mains; then estimate or calculate the lamp centre of the resultant group (comprising all the lamps), which in this case we will suppose to be 20 feet from the overlapping mains measured at right angles, and 48 from the distributing point measured along the main, and refer to the table with 20 + 48 + 20 feet, or 88 feet for 150 lights, *or for the largest number of lights that will ever be used at one time.*

In simple cases the quantities may be estimated, either directly (especially for branches) or from rough diagrams, and for more complex cases or where a perfectly accurate result is desired the following rules are given:

For branches, follow the method given above.

For mains, multiply the number of lamps on each branch of a main by the distance of the lamp centre from the distributing point, *always measured along the lead of the main and branch*; add the products thus obtained for all

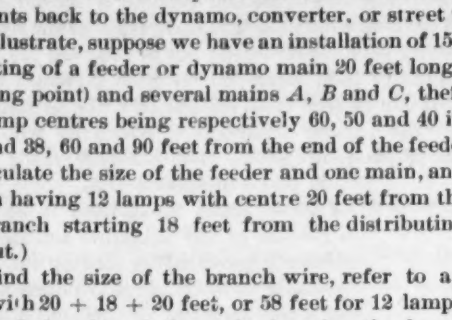


Diagram of Lamp Distribution.

the branches on the main and divide by the whole number of lamps on the branches. Add the length of feeder and refer to the table with the resultant distance and lamps.

Example.—(See cut, main *A*.)

$$(18 + 20) \times 12 = 456$$
$$(33 + 30) \times 30 = 1890$$
$$(60 + 15) \times 18 = 1350$$
$$\frac{456 + 1890 + 1350}{12 + 30 + 18} + 20 = 81 \text{ feet for 60 lamps.}$$

For feeders, add the sum of the products obtained as above for all the mains, divide by the entire number of lamps on the feeder, add the length of the feeder, and refer to the table with this distance and all the lamps on the feeder, *or the largest number that will ever be used at one time.*

Example.—(See cut.)

Main *A*. $456 + 1890 + 1350 = 3696$
Main *B*. $60 \times 50 = 3000$
Main *C*. $90 \times 40 = 3600$

$$\frac{3696 + 3000 + 3600}{150} + 20 = 88 \text{ feet for 150 lamps.}$$

Care must be taken not to confound a *lamp* centre (so called) with a *geometrical* centre. For example, suppose a series of branches of equal length radiating from the end of a main like the spokes of a wheel, and having lamps at equal intervals. Here the geometrical centre is the radiating point, while the lamp centre is on a circle passing through the centres of the various groups, or the length of the radius from the radiating point. In the case of the main *A* given above, the geometrical centre is 15 ft. from the main, while the true lamp centre is 23 ft. It is to preclude the error of geometrical centres that the branches and mains are laid down, or imagined, revolved.

Sub branches and taps may in general be considered as groups of lamps directly on the branch itself, and thus included in the calculation for the branch.

The above method is applicable to all systems of wiring, and is particularly valuable and economical in securing proper distribution of light on low voltage circuits having a small precentage of loss. By stringing the branches first, when possible, this method may be easily followed without the aid of a diagram, even in complex cases. With the "closet" system of wiring, diagrams and calculations as a rule will not be required.

The "tree" system of wiring is to be avoided where possible, on account of the unequal distribution of light it entails. In many cases secondary centres of distribution may be substituted, and if carefully calculated the weight of wire in the latter case need not exceed that in the former.

The voltmeter should always be connected with the centre of distribution, and not with the feeder near the dynamo. If it is desirable to have a steady light in a particular locality, it should be connected with the wire there. Owing to the exceedingly small current passing through the voltmeter, the resistance of even a small wire in ordinary cases will not practically affect its readings. Where the line is very long, a No. 12 or 14 insulated iron wire may be used, and the voltmeter at the dynamo set once for all by comparison with a standard voltmeter temporarily attached at the point which is to be maintained at a constant potential.

WIRING FORMULÆ AND TABLES.

A formula for calculating wiring tables is

$$A = \frac{2150\ W}{a\ E^2}\ L\ N \qquad (1)$$

where A = section in circular mils.
W = watt rating of lamps.
E = voltage.
L = distance to centre of distribution, in feet.
N = number of lamps.
a = percentage of drop.

Table I., below, was calculated on the basis of 55 watts to a 16-c. p. lamp. While there are lamps taking somewhat less current, it is advisable to allow some margin in wiring

The ampères (C) being given, the size of wire in circular mils can be found from the following formula:

$$A = \frac{2150\ L\ C}{a\ E} \qquad (2)$$

Example.—Volts, 50; ampères, 100; feet to centre of distribution, 100; drop, 2%.

$$\frac{2.150 \times 100 \times 100}{2 \times 50} = 215{,}000 \text{ circular mils.}$$

By referring to a table of circular mils this will be found to be about No. 0000 B. & S.

The horse power (h. p.) and efficiency (*eff.*) of a motor being given, the size of the conducting wire in circular mils can be found from the following formula:

$$A = \frac{160{,}400{,}000 \times H.\ P. \times L.}{aE^2 \times eff.} \qquad (3)$$

Example.—Horse power, 10; volts, 500; drop, 3 per cent.; feet to distributing point, 600; efficiency of motor, 75 per cent.

$$A = \frac{160{,}400{,}000 \times 10 \times 600}{3 \times 500 \times 500 \times 75} = 17{,}109 \text{ circular mils, or}$$

about No. 8 B. & S.

The gauge may be directly taken from wiring (lamp) tables by means of the following formula of lamp equivalent (Q):

$$Q = \frac{1{,}360\ H.\ P.}{eff.}. \qquad (4)$$

Example.—Horse power, 5; volts, 110; drop, 3 per cent.; feet to distributing point, 300; efficiency of motor, 75 per cent.

$$Q = \frac{1{,}360 \times 5}{75} = \text{lamp equivalent} = 90.$$

Referring to Table I., we find that No. 2 B. & S. wire corresponds to 90 lamps and 200 feet, the drop being 3 per cent.

If the distance had been 400 feet, we could still have referred to the 200-foot column, but with 2×90, or 180 lamps.

Having the horse power and efficiency of a motor, to find the ampères with which to enter a wiring (ampère) table, or to apply formula (2), we have the following:

$$C = \frac{149\ H.\ P.}{eff.}. \qquad (5)$$

Example.—Horse power, 7½; efficiency, 80 per cent.

$$C = \frac{7\frac{1}{2} \times 149}{80} = 13.9 \text{ ampères.}$$

By means of Table II. the three wiring tables in common use can be used for any voltage or percentage of loss with an accuracy within the limits of practice.

For example, suppose the wiring is to be for 90 volts with

WIRING TABLE I.—110 VOLTS.

Number of lamps. Per cent of loss.						16 c. p. lamp. B. & S. gauge.																Heating limits.	
1%	2%	3%	4%	5%	10%	20′	25′	30′	35′	40′	45′	50′	60′	70′	80′	90′	100′	120′	140′	160′	180′	200′	Gauge wire.	No. of lamps.
½	1	1	2	2	5	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	10
1	2	3	4	5	10	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	14	20
1	3	4	6	7	15	16	16	16	16	16	16	16	16	16	16	16	16	16	16	16	15	15	12	30
																							10	40
2	4	6	8	10	20	16	16	16	16	16	16	16	16	16	16	16	16	16	15	15	14	14	8	50
2	5	7	10	12	25	16	16	16	16	16	16	16	16	16	16	16	16	15	14	14	13	13	7	60
3	6	9	12	15	30	16	16	16	16	16	16	16	16	16	16	15	15	14	14	13	12	12	6	70
																							5	90
3	7	10	14	17	35	16	16	16	16	16	16	16	16	16	15	15	14	14	13	12	12	11	4	100
4	8	12	16	20	40	16	16	16	16	16	16	16	16	15	15	14	14	13	12	12	11	11	3	120
4	9	13	18	22	45	16	16	16	16	16	16	16	15	15	14	14	13	12	12	11	11	10	2	140
																							1	190
5	10	15	20	25	50	16	16	16	16	16	16	16	15	14	14	13	13	12	11	11	10	10	0	200
6	12	18	24	30	60	16	16	16	16	16	15	15	14	14	13	12	12	11	11	10	9	9	00	240
7	14	21	28	35	70	16	16	16	16	15	15	14	14	13	12	12	11	11	10	9	9	9	000	290
																							0000	350
8	16	24	32	40	80	16	16	16	15	15	14	14	13	12	12	11	11	10	9	9	8	8		
9	18	27	36	45	90	16	16	15	15	14	14	13	12	12	11	11	10	9	9	8	8	7		
10	20	30	40	50	100	16	16	15	14	14	13	13	12	11	11	10	10	9	9	8	7	7		
12	25	37	50	62	125	16	15	14	13	13	12	12	11	10	10	9	9	8	8	7	6	6		
15	30	45	60	75	150	15	14	13	13	12	11	11	10	10	9	9	8	7	7	6	6	5		
17	35	52	70	87	175	14	14	13	12	11	11	11	10	9	9	8	8	7	6	5	5	4		
20	40	60	80	100	200	14	13	12	12	11	10	10	9	9	8	7	7	6	5	5	4	4		
22	45	67	90	112	225	13	12	12	11	10	10	9	9	8	7	7	6	6	5	4	3	3		
25	50	75	100	125	250	13	12	11	11	10	9	9	8	8	7	6	6	5	4	4	3	3		
27	55	82	110	137	275	12	12	11	10	9	9	9	8	7	6	6	5	5	4	4	3	3		
30	60	90	120	150	300	12	11	10	10	9	9	8	7	7	6	6	5	4	4	3	3	2		
32	65	97	130	162	325	12	11	10	9	9	8	8	7	6	6	5	5	4	3	3	2	2		
35	70	105	140	175	350	11	11	10	9	9	8	8	7	6	5	5	4	4	3	2	2	1		
40	80	120	160	200		11	10	9	9	8	7	7	6	5	5	4	4	3	2	2	1	1		
45	90	135	180	225		10	10	9	8	7	7	6	6	5	4	4	3	3	2	1	1	0		
50	100	150	200	250		10	9	8	8	7	6	6	5	4	4	3	3	2	1	1	0	0		
55	110	155	220	275		9	9	8	7	6	6	5	5	4	3	3	2	2	1	0	0	00		
60	120	180	240	300		9	8	7	7	6	6	5	4	4	3	3	2	1	1	0	0	00		
65	130	195	260	325		9	8	7	6	6	5	5	4	3	3	2	2	1	0	0	00	00		
70	140	210	280	350		9	8	7	6	5	5	4	4	3	2	2	1	1	0	00	00	000		
75	150	225	300			8	7	6	6	5	5	4	3	3	2	1	1	0	0	00	00	000		

TABLE II.—ODD VOLTAGES AND PERCENTAGES.

	50 Volts.					55 Volts.					60 Volts.					65 Volts.				
Per cent. column	1%.	2%.	3%.	4%.	5%.	1%.	2%.	3%.	4%.	5%.	1%.	2%.	3%.	4%.	5%.	1%.	2%.	3%.	4%.	5%.
50-volt table	1.0	2.0	3.0	4.0	5.0	.8	1.6	2.4	3.3	4 1	.7	1.4	2.1	2.8	3.5	.6	1.2	1.8	2.4	3.0
75 " "	2.2	4.5	6.7	9.0	12.2	1.8	3.7	5.6	7.4	9.3	1.5	3.1	4.7	6.2	7.8	1.3	2.6	3.9	5.2	6.5
100 " "	4.8	9.6	14.4	19 2	24.0	4.0	8 0	12.0	16.0	20.0	3.4	6.7	10.0	13.4	16.8	2.8	4.7	8.6	11.5	13.3

	70 Volts.					75 Volts.					80 Volts.					85 Volts.				
Per cent. column	1%.	2%.	3%.	4%.	5%.	1%.	2%.	3%.	4%.	5%.	1%.	2%.	3%.	4%.	5%.	1%.	2%.	3%.	4%.	5%.
50-volt table	.5	1.0	1.5	2.0	2.5	.4	.9	1.3	1.8	2.2	.4	.8	1.2	1.6	2.0	.3	.7	1.0	1.4	1.7
75 " "	1.2	2.3	5.4	4.6	5.7	1.0	2.0	3.(	4.0	5.0	.8	1.6	2.4	3.2	4.1	.8	1.6	2.3	3.1	4.0
110 " "	2 5	5.0	7.5	10.0	12.5	2.1	4.2	6 3	8.4	10.5	1.9	3.8	5.7	7.6	9.5	1.7	3.4	5.1	6.8	8.5

	90 Volts.					95 Volts.					100 Volts.					105 Volts.				
Per cent. column	1%.	2%.	3%.	4%.	5%.	1%.	2%.	3%.	4%.	5%.	1%.	2%.	3%.	4%.	5%.	1%.	2%.	3%.	4%.	5%.
50-volt table	.3	.6	.9	1.2	1.5	.3	.5	.8	1.0	1.3	.2	.5	.7	1.0	1.2	.2	.4	.7	.9	1.2
75 " "	.7	1.4	2.1	2.8	3.5	.6	1.2	2.0	2.5	3.1	.5	1.1	1.7	2.2	2.8	.5	1.0	1.5	2.0	2.5
110 " "	1.5	3.0	4.5	6.0	7.5	1.3	2.7	4.0	5.4	6.7	1.2	2.4	3.6	4 8	6 0	1.1	2.2	3.3	4.4	5.5

	110 Volts.					115 Volts.					120 Volts.					125 Volts.				
Per cent. column	1%.	2%.	3%.	4%.	5%.	1%.	2%.	3%.	4%.	5%.	1%.	2%.	3%.	4%.	5%.	1%.	2%.	3%.	4%.	5%.
50-volt table	.2	.4	.6	.8	1.0	.2	.4	.6	.8	1.0	.2	.3	.5	.7	.8	.2	.3	.5	.7	.8
75 " "	.4	.9	1 4	1.8	2 3	.4	.8	1.3	1.7	2.1	.4	.8	1.2	1 6	2.0	.4	.7	1.0	1.4	1.8
110 " "	1.0	2.0	3.0	4.0	5.0	.9	1.8	2.7	3.6	4.5	.8	1.7	2.5	3.3	4.2	.8	1.5	2.2	3.0	3.8

* From Davis' Standard Wiring Tables, third edition. Thoroughly revised and edited by W. D. Weaver. (In press.) The W. J. Johnston Company, Limited.

2 per cent loss. Referring to the body of the 90-volt section of Table II. we find the nearest percentage of loss given is 2.1 per cent.; then following the horizontal and vertical columns in turn we find that this corresponds to a 75-volt table, using the 3 per cent. column of that table. That is, wiring for 75 volts with 3 per cent. loss is the same as wiring for 90 volts with 2.1 per cent. loss.

Similarly, we find that for a loss of .6 per cent. with 110 volts we may use the 3 per cent. column of a 50 volt table.

The Efficiency of Transformers at Different Frequencies.—II.*

BY W. E. AYRTON AND W. E. SUMPNER.

Before summarizing the results obtained it will be well to explain in detail the arithmetical working by means of which the efficiency is obtained from a single set of measurements with the three instruments W_1, W_2 and D. When the two large Mordey transformers (M_1 and M_2) were being tested at a frequency of 107 it was observed that when the current as read by D was 44.8 ampères, W_1 indicated 310 watts, and W_2 indicated 290 watts. In this particular experiment M_1 was on the mains at 100 volts and was used as a step-down transformer, the volts on the primary of M_2 being greater than 100 volts. While, therefore, 44.8×100 watts were being returned to the mains by M_1, the thick coil of transformer M_2 was being supplied with 4,480 + 310 + 290 watts. The load on the step-up transformer was thus 5,080 watts. The total loss in the two transformers is, however, less than 600 watts, since there is a considerable loss in the leads and dynamometers, etc. The loss in the leads at 44.8 ampères is 63 watts. The thin coil of W_1 was used in this particular test so that an additional loss of 89 watts must be allowed for. No extra allowance has to be made for D, as the thick coil was used and the loss in this coil is already taken into account in estimating the loss in the leads. The total loss in the testing apparatus for this current is therefore 152 watts, and the total loss in the transformers is thus $600 - 152 = 448$ watts. The joint efficiency at this load of 5,080 watts is therefore $1 - \frac{448}{5{,}080} = 1 - .0883 = 91.18$ per cent. This number is the product of the efficiencies of the two transformers, and, if these are assumed to be equal, the true efficiency is obtained by taking the square root of 0.9118, giving 95.5 per cent. Also if the copper losses at this current, determined by the method already described, be subtracted from the total loss of 448 watts we obtain 275 watts as the iron losses at this load. This only differs by 15 watts from the actual reading of W_2.

This process has been gone through for each of the efficiency determinations made; but in order to simplify the work curves have been plotted denoting respectively the losses in the leads and transformers, the total losses in the transformers, the losses in the core, and the corresponding power supplied by the mains and measured by W_2.

The curves shown in Fig. 2 indicate a complete set of observations made on the two large Mordey transformers M_1 and M_2. As many as thirty such sets were taken in connection with different combinations of the tranformers. Several of these had to be rejected from various causes. For instance, it was at first arranged by means of a combination of switches to make one wattmeter do the work of the instruments W_1 and W_2, but after several measurements had been taken it was found that the alteration of the resistance of the circuit caused by the introduction of the wattmeter coil altered the currents flowing to a serious extent. The majority of the tests, however, confirmed each other in a very satisfactory manner. It is unnecessary to give the details of all the measurements, and we shall, therefore, merely give the numbers denoting the losses at different loads. These losses are interpolated from the curves drawn through the actually plotted points. The following table shows the results obtained from five sets of observations at various frequencies on the two large transformers M_1 and M_2.

COMBINED LOSSES IN TWO 4½ KILOWATT TRANSFORMERS OF THE MORDEY TYPE.

Load in watts.	Approximate frequency in periods per second.		
	100	120	160
	Loss in watts in the two transformers.		
1,000	292	270	229
2,000	305	280	241
3,000	335	305	275
4,000	375	345	320
4,500	400	...	...
5,000	425	...	...

From these numbers we obtain the following values for the efficiency of each of these two transformers:

Load in watts.	Approximate frequency in periods per second.		
	100	120	160
	Efficiency of each transformer.		
1,000	84.46	85.59	88.58
2,000	92.19	92.76	93.84
3,000	94.27	94.79	95.30
4,000	95.22	95.60	95.91
4,500	95.46	.....	.....
5,000	95.76	.....	.....

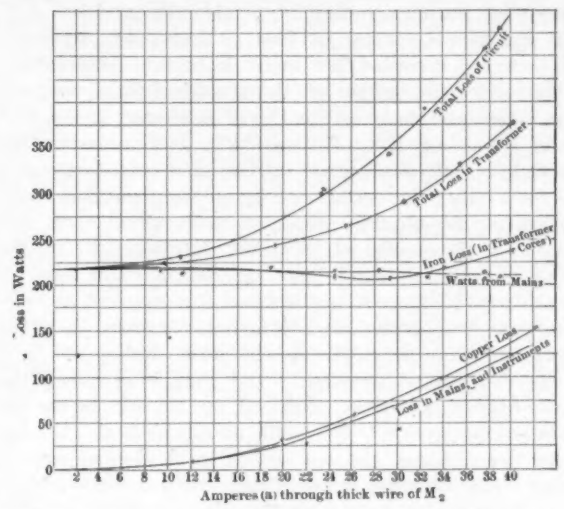
*Read at the meeting of the British Association, Aug. 5, 1892.

From these numbers it follows: 1st. That the greater the frequency the higher the efficiency for any particular load. 2d. That the greater the load the higher the efficiency for the same frequency.

Both these results follow of course from the fact that the iron losses are the same at all loads for a given frequency and diminish as the frequency increases. And they do not, for these particular transformers at any rate, confirm the results referred to at the commencement of this paper that the efficiency is a maximum at the frequency of 100.

The open circuit losses expressed as percentages of full load are 3.2 per cent., 2.8 per cent. and 2.36 per cent. at frequencies of 100, 120 and 160 periods per second.

If the iron losses be constant for all loads at a given frequency it can easily be proved that the efficiency of a transformer must be a maximum when the copper losses become equal to the iron losses. And calculation shows that,


Total Loss of circuit
Total Loss in Transformer
Iron Loss (in Transformer Cores)
Watts from Mains
Copper Loss
Loss in Mains and Instruments
Losses in Watts
Amperes (a) through thick wire of M2

CURVE OF LOSSES IN NOS. 1872 AND 1874 MORDEY TRANSFORMERS.

Primary volts, 100; Frequency, 150; M_1 used as step down transformer; M_2, used as step up transformer; Load = $100a$ + total losses.

for these two 4½ kilowatt transformers of the Mordey type, this equality will occur at a load of 7,200 watts at a frequency of 100, at a load of 5,500 watts at a frequency of 160, and at a load of 5,000 watts at a frequency of 200 periods per second, when the maximum efficiencies become 96 per cent., 96.1 per cent., and 96.3 per cent respectively. There is, therefore, no great difference between the maximum efficiencies at different frequencies, but the higher the frequency the lower the load at which the maximum efficiency occurs.

The following table summarizes the results obtained from the tests of the 3,000 watt (M_2) and the 4,500 watt (M_1) transformers of the Mordey type combined:

Load in watts.	Frequency in periods per second.		
	107	160	200
	Loss in watts in the two transformers.		
0	235	185	175
3,000	320	265	255
4,000	410	340	365

From these numbers we obtain the following values for the joint efficiencies of these two transformers.

Load in watts.	Frequency in periods per second.		
	107	160	200
	Joint efficiency of the two transformers.		
3,000	89.33	91.17	91.50
4,000	89.75	91.50	90.88

Now from the former tests we know the efficiency of M_1 at these loads and at two of the frequencies. We can thus obtain, by division, the efficiency of M_2 as follows:

Load in watts.	Frequency in periods per second.	
	107	160
	Efficiency of transformer M_2.	
3,000	94.76	95.67
4,000	94.25	95.47

The efficiency of the small 1,500 watt transformer (M_4) of the Mordey type was tested at a frequency of 150 and found to be 90.2 per cent. at a load of 1,500 watts and higher at a larger output. The method used in testing this transformer is of some interest, arising from the fact that, as already stated, this transformer was for special experimental reasons so wound that it transformed from 100 volts to 100 volts. Now when the change ratio of a transformer is unity it is not necessary to employ another similar transformer when using our method of testing the losses directly, since the primary and secondary coils can be employed, one to take energy from the mains and the other to give back what is not lost in the transformation. Of course an auxiliary transformer (C, Fig. 1) must be employed, but the two transformers A and B in the figure are replaced with the single unity change ratio transformer M_4.

As the large transformers of the Mordey type are wound with two thick coils in addition to the fine wire coil, in order that the transformers may, if required, be used on the three-wire system, it is possible to measure the efficiency by the method just described without the employment of a second similar transformer. And tests that we made in this way confirmed those previously carried out.

But as the fine wire coil of the transformer is not used, this method, although excellent for a transformer whose change ratio is unity, is not to be recommended for one which transforms from 50 or 100 to 2,000 volts. Indeed it is obvious that if the test be made in the way just described the advantage of dispensing with the duplicate transformer is counterbalanced by the fact that the transformer tested can only be used at what is practically half load, and the copper losses are therefore proportionately greater than when the transformer is used in the ordinary way at full load. Employing, therefore, two similar transformers, as well as a small auxiliary transformer as in Fig. 1, is much to be preferred.

A large number of tests were made by combining the hedgehog transformer H with M_1 and with M_2, and, although the results (as already mentioned) were not as satisfactory as when two Mordey types of transformers were employed, they were sufficiently accurate to show that neither at no load nor at full load is there any great difference apparently between the power wasted in a hedgehog and a Mordey type of transformer of the same output. On this point, however, we shall say more when we have had more time to analyze the results we have already obtained with the hedgehog transformer.

In conclusion, we wish to express our thanks to the Brush company for so kindly lending us the two 4½ kilowatt transformers, and also our obligations to several students at the Central Institution, and more especially to Messrs. Baillie, Baylay and Clift for their interest and energy in carrying out the experiments and in reducing the results.

Important Decisions in the United States Court of Appeals.

Simultaneously with the decision of the Edison incandescent lamp patent case, the United States Circuit Court of Appeals handed down two other decisions of considerable importance.

The first was the case of the Brush-Swan Electric Company vs. the Brush Electric Company. This action was to enforce a contract made May 23, 1878, by which the Brush-Swan Electric Light Company was to act as exclusive agent of the Brush Electric Company in certain territory. The Brush-Swan company was to buy from the Brush Electric Company its machinery at a certain discount and furnish it to local electric light companies, manufacturers or individuals, and this agreement was continued in force for 17 years, unless abrogated before that time by mutual consent or by the decision of arbitrators, or unless at any time the financial condition of the Brush-Swan company became such as not to warrant the Brush Electric Company to permit it to have charge of its business in the specified territory. On Oct. 27, 1887, the Brush Electric Company declared the contract annulled, whereupon the Brush-Swan company brought action against it. The case was tried in the Circuit Court and a decision was rendered that there had been no breach of contract on the part of the Brush-Swan company, and that the contract must in the future be enforced. The United States Circuit Court of Appeals now reverses this decision on the ground that the terms of the agreement between the two companies could not possibly have been carried out by the defendant company.

The second decision was in the case of the Electric Accumulator Company et al. vs. the Brush Electric Company. The Circuit Court for the Southern District of New York had rendered a decision which enjoined the Electrical Accumulator Company against the infringement of the seventh and fourteenth claims of the Brush patent No. 266,090, Oct. 17, 1882, and the first, second, third, sixth, seventh and twelfth claims of the Brush patent No. 337,299. March 2, 1886, for improvements in secondary batteries. The Circuit Court of Appeals decides that, in respect to the patent No. 266,090, the broadening of the scope of the patent by the insertion of new matter while the patent was pending in the Patent Office should not have been allowed, and that there is no infringement of this patent. The decree of the lower court is therefore modified to this extent, with costs to the appellants, but in other respects it is affirmed.

Consolidation of Edison Interests in Canada.

The Edison Incandescent Light Company, of Toronto, with a capital of $1,500,000, with W. P. Brock as president and E. B. Osler and other large capitalists as directors, is taking steps to acquire and consolidate under its control the various Edison electrical works in different parts of Ontario. It has purchased already the Edison General Electric Company of Hamilton and the Edison establishment at Peterboro, and will operate them in connection with its Toronto business.

Chronological History of Electricity—Part II.—1800-1820.

BY P. F. MOTTELAY.

A. D. 1803.——Biot (Jean Baptiste), who, in 1800, at the age of 26, was made professor of natural philosophy at the "Collège de France," and afterward ranked among the first astronomers and mathematicians, gives an account of his journey to Aigle, in the Department of l'Orne, whither he was sent by the government to examine and report upon a very extraordinary shower of meteorites. The facts obtained by him, and which have since remained data for the investigation of similar phenomena, were communicated to the Institute on the 29th Messidor, an XI., and also appeared at the time in the Paris *Journal des Débats.*[1]

On the 23d of August of the year following (1804) Biot accompanied Gay-Lussac in the latter's first memorable balloon ascent. This aeronautic voyage, which received the sanction of the French government mainly through the efforts of Berthollet and Laplace, was the first of the kind undertaken solely for a scientific object.

Besides a liberal provision of barometers, electrometers, etc., Biot and Gay-Lussac carried with them two compasses and a dipping needle, as well as another fine needle carefully magnetized and suspended in such manner as to readily indicate by its vibrations the force of magnetic attraction. For the examination of the electricity of different strata of the atmosphere, they had several metallic wires from 60 to 300 feet in length, and a small electrophorus feebly charged, while for galvanic experiments they added some discs of copper and zinc, together with a supply of frogs, insects and birds. An account of the exceedingly important results obtained by those scientists at different elevations, of which the highest reached exceeded four miles, was read before the National Institute, Aug. 27, 1804. It was also published in London during the latter year, and alluded to at page 371, vol. xix., of the *Philosophical Magazine.* Mary Somerville remarks[2] that according to the observations of Biot and Gay-Lussac, the magnetic action is not confined to the surface of the earth, but extends into space. The moon has become highly magnetic by induction, in consequence of her proximity to the earth, and because her greatest diameter always points toward it. Her influence on terrestrial magnetism is now ascertained; the magnetism of the hemisphere that is turned toward the earth attracts the pole of our needles that is turned toward the south and increases the magnetism of our hemisphere; and as the magnetic, like the gravitating force, extends through space, the induction of the sun, moon and planets must occasion perpetual variations in the intensity of terrestrial magnetism, by the continual changes in their relative positions.

In 1805 Biot published an investigation of the laws which should govern the dip and intensity, in the hypothesis of a magnet situated at the centre of the earth, having its poles infinitely close to each other and directed to opposite points on the surface of the globe and, adds Major Edward Sabine (Report Seventh Meeting Brit. Asso.), it is a well-known consequence of this hypothesis that the lines of equal dip and equal intensity on the earth's surface should everywhere be parallel to each other.[3]

The phenomena of electricity had been brought within the pale of mixed mathematics by C. A. Coulomb, whose considerations mainly attached to the distribution of electricity upon the surface of spheres, and his investigations were at once diligently pursued by the French scientists, Laplace, Biot and Poisson. Laplace, who undertook to investigate the distribution of electricity upon the surface of ellipsoids of revolution, showed that the thickness of the coating of the fluid at the pole was to its thickness at the equator as the equatorial is to the polar diameter, or, what is the same thing, that the repulsive force of the fluid, or its retention at the pole, is to that at the equator as the polar is to the equatorial axis. Biot extended this investigation to all spheroids differing little from a sphere, whatever may be the irregularity of their figure, and his solution of the problem will be found in No. li. of the *Bulletin des Sciences.* He also determined, analytically, that the losses of electricity form a geometrical progression when the two surfaces of a jar or plate of coated glass are discharged by successive contacts, and he found that the same law regulated the discharge when a series of jars or plates are placed in communication with each other.[4]

In conjunction with Frederick Cuvier, Mr. Biot investigated the connection of chemical charge with the production of electricity. Like Mr. W. H. Pepys, they examined the effect produced by the pile on the atmosphere in which it is placed. Mr. Pepys placed the pile in an atmosphere of oxygen, and found that in the course of a night 200 cubic inches of the gas had been absorbed, but that in an atmosphere of azote the pile ceased to act. Biot and Cuvier likewise observed the quantity of oxygen absorbed, and inferred from their experiments that "although, strictly speaking, the evolution of electricity in the pile was produced by oxidation, the share which this had in producing the effects of the instrument bore no comparison with that which was due to the contact of the metals, the extremity of the series being in communication with the ground." Their discovery was attended by a circumstance worth noting, namely, that as long as there remained any oxygen to be absorbed the chemical and physiological effects of the apparatus still continued, although with decreasing intensity; so that if the conducting wires attached to the two poles be made to return from under the receiver in tubes of glass they may be used to decompose water and communicate shocks to the organs. But all these effects cease when the surrounding oxygen is exhausted.[5]

In the second volume of Biot's "Traité de Physique" will be found recorded his many important observations on the nature and origin of the electrical light, extracts from which are given by Sir David Brewster in the electricity article of the "Britannica." Biot remarks that the light which is observed during an electric explosion was for a long time considered by philosophers as a modification of the electric principle itself, which they supposed to be the quality of becoming luminous at a certain degree of accumulation.[6] Brewster adds that this eminent French writer, however, considered this opinion as erroneous, and has devoted a whole chapter to prove that electricity has the same origin as the light disengaged from air by mechanical pressure, "and that it is purely the effect of the compression produced on the air by the explosion of electricity." In order to establish this theory, M. Biot has stated, on the authority of several experiments, "that the intensity of electric light depends always on the ratio which exists between the quantity of electricity transmitted and the resistance of the medium;" and he has shown, by an experiment with Kinnersley's thermometer, "that at each spark the air of the cylinder, driven by the repulsive force, presses on the surface of mercury, which rises suddenly in the small tube, and falls back again immediately after the explosion." He adds:

> This indication proves the separation produced between the particles of the mass of air where the electricity passes; and from what we know of its extreme velocity it is certain that the particles exposed immediately to its shock ought in the first moment to sustain individually all the effect of the compression They ought, then, from this cause alone to disengage light, as when they are subjected to any other mechanical pressure. Thus one part at least of the electric light is necessarily due to this cause; and this being the case, there is no experiment which can lead us to conjecture that it is not all due to this cause.[7]

J. B Biot's son, Edward Constant Biot (1803—1850), is the author of the extended catalogue of shooting stars and other meteors observed in China during twenty-four centuries, which was presented to the French Academy during 1841, and a supplement to which was published at Paris in 1848 (*Acad. des Sciences, Savants étrangers*, tome x.)

A. D. 1803-1805.——Acting upon the discovery of Gautherot, the Bavarian philosopher Johann Wilhelm Ritter is the first to construct an electrical accumulator.

Ritter's "ardency of research and originality of invention" had, as far back as 1796, vividly shown itself in the numerous very able scientific papers relating to Electricity, Galvanism and Magnetism which he had communicated mainly through L. W. Gilbert's *Annalen der Physik*, J. H. Voigt's *Mag. für Naturk* and A. F. Gehlen's *Journal für Chemie*, and which obtained recognition in several foreign publications. These papers secured for him membership in the Munich Academy during the year 1805.

From Prof. H. W. Dove's discourse before the Society for Scientific Lectures, of Berlin, the following is extracted:

> As the (then considered) essential portions of a galvanic circuit were two metals and a fluid, innumerable combinations were possible, from which the most suitable had to be chosen. This gigantic task was undertaken by Ritter, an inhabitant of a village near Leignitz, who almost sacrificed his senses to the investigation. He discovered the peculiar pile which bears his name, and opened that wonderful circle of actions and reactions which, through the subsequent discoveries of Oersted, Faraday, Seebeck and Peltier, drew with ever tightening band the isolated forces of nature into an organic whole. But he died early (1776-1810) as Günther did before him, exhausted by restless labor, sorrow and disordered living.

Ritter 's *charging or secondary pile* consists of but one metal, the discs of which are separated by circular pieces of cloth, flannel or cardboard, moistened in a liquid which cannot chemically affect the metal. When the extremities of this pile are put in communication with the poles of an ordinary voltaic pile it becomes electrified and can be substituted for the latter, and it will for a time retain the charge so that there can be obtained from it sparks, shocks, as well as the decomposition of water.

The writer of the article at page 268 of the April 1802 *Monthly Magazine* making reference to *an artificial magnet* recently discovered at Vienna[8] no doubt alludes to the above named charging or secondary pile, in the construction of which Ritter made many modifications. At first he arranged 32 copper and card discs in three series, two of which contained 16 copper discs while the intermediate series consisted of the 32 card discs. He then placed them so that the discs alternated, employing but 31 discs of copper, and he also used 64 as well as 128 copper discs alternating with similar ones of cardboard. In each case he compared the chemical action through the decomposition of water as well as the physiological effect or shock and the physical property or electrical tension. The results obtained are given in his many papers alluded to below.

He discovered the property which the voltaic pile has of decomposing water as well as saline compounds, and of collecting oxygen and acids at the positive pole while hydrogen and the bases collect at the negative pole. This he did independently of the English scientists. He conceived that he had procured oxygen from water without hydrogen, by making sulphuric acid the medium of the communication at the negative surface, but, as Davy says, in this case sulphur is deposited, while the oxygen from the acid and the hydrogen from the water are respectively repelled, and the new combination produced.

A correspondent in Alex. Tilloch's *Philosophical Magazine*[9] thus alludes to some of Ritter's experiments communicated in May, 1805, to the the Munich Royal Society:

> I have seen him galvanize a louis d'or. He places it between two pieces of pasteboard thoroughly wetted, and keeps it six or eight minutes in the circuit of the pile. Thus it becomes charged, though not immediately in contact with the conducting wires. If applied to the recently bared crural nerves of a frog the usual contractions ensue. I put a louis d'or thus galvanized into my pocket, and Ritter told me, some minutes after, that I might discover it from the rest by trying them in succession upon the frog. I made the trial, and actually distinguished, among several others, one in which only the exciting quality was evident. The charge is retained in proportion to the time that the coin has been in the circuit of the pile. Thus, of three different coins, which Ritter charged in my presence, none lost its charge under five minutes. A metal thus retaining the galvanic charge, though touched by the hand and other metals, shows that this communication of galvanic virtue has more affinity with magnetism than with electricity, and assigns to the galvanic fluid an intermediate rank between the two. Ritter can, in the way I have just described, charge at once any number of pieces. It is only necessary that the two extreme pieces of the number communicate with the pile through the intervention of wet pasteboards. It is with metallic discs charged in this manner, and placed upon one another, with pieces of wet pasteboard alternately interposed, that he constructs his charging pile, which ought, in remembrance of its inventor, to be called the *Ritterian pile.* The construction of this pile shows that each metal galvanized in this way acquires polarity, as the needle does when touched with a magnet.

The same correspondent alludes to experiments made with Ritter's battery of 100 pairs of metallic plates, the latter having their edges turned up so as "to prevent the liquid pressed out from flowing away,"[10] but he could not see Ritter's great battery of 2,000 pieces, nor the one of 50 pieces, each 36 inches square, the action of which continued very perceptible for a fortnight. He continues as follows:

> After showing me his experiments on the different contractibility of various muscles ("Beiträge zur näheren Kenntrviss, etc.," Jena, 1802, B. ii.) Ritter made me observe that the piece of gold galvanized by communication with the pile exerts at once the action of two metals, or of one voltaic couple, and that the face which in the voltaic circuit was next the negative pole became positive, and the face toward the positive pole negative. Having discovered a way to galvanize metals as iron is rendered magnetic, and having found that the galvanized metals always exhibit two poles as the magnetized needle does, Ritter suspended a galvanized gold needle on a pivot, and perceived that it had a certain dip and variation, or deflection, and that the angle of deviation was always the same in all his experiments. It differed, however, from that of the magnetic needle, and it was the positive pole that always dipped.

The nearest approach to a solution of the question as to the analogy between electric and magnetic forces, which had remained unsettled since the time of Van Swinden (see A. D. 1784), was given by Ritter, who announced "that a needle composed of silver and zinc arranged itself in the magnetic meridian and was slightly attracted and repelled by the poles of a magnet;" he also stated "that by placing a gold coin in the voltaic circuit, he had succeeded in giving to it positive and negative electric poles; and that the polarity so communicated was retained by the gold after it had been in contact with other metals, and appeared therefore to partake of the nature of magnetism; that a gold needle under similar circumstances acquired still more decided magnetic properties;" and, "that a metallic wire, after being exposed to the voltaic current took a direction N. E. and S.W." Dr. Roget gives these same extracts in his article on Electro-Magnetism, and justly remarks that Ritter's speculations were of too crude a nature to throw any distinct light on the true connection between magnetism and electricity. But little notice was in fact taken of Ritter's announcements, owing to the vague manner in which they were made, nor were any satisfactory results obtained until the year 1819, when Oersted made his famous discovery which forms the basis of the science of electromagnetism.[11]

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[1] See, likewise, *Phil. Mag.*, vol. xvi., p. 299.

[2] "Connection of the Physical Sciences," 1846, p. 331.

[3] "Encycl. Brit.," 1857, vol. xiv., pp. 7, 63, and *Journal de Physique*, vol. lix., p. 450. For Mr. Biot's observations on the magnetism of metals and minerals, and on the distribution of magnetism in artificial magnets, as well as for his improvement upon Coulomb's method of constructing the latter, see the last named volume of the "Britannica," pp. 23, 26, 71, and Noad's "Manual of Electricity," London, 1859, pp. 528, 535, while, for Biot's very ingenious theory relative to the aurora, see Lardner and Walker's "Manual of Elec. Mag. and Meteor.," London, 1844, vol. ii., p. 235, and Noad, pp. 232, 233. The observations concerning the laws regulating the intensity of electromagnetic phenomena, made by MM. Biot and Savart, are alluded to by Noad at pp. 644, 645, in the "Encycl. Metropol." (Elec. Magn.), vol. iv., p. 427; and Whewell's "History of the Inductive Sciences," 1859, vol. ii., pp. 245-249.

[4] Whewell, "History of the Inductive Sciences," vol. ii., pp. 208, 223; Noad's "Manual," p. 15; Eighth Britannica, vol. viii., p 581. For Biot's experiments, touching upon electrical attraction and demonstrating practically the distribution of electricity upon the surface of a conductor, see the last-named volume of the "Britannica," pp. 552-556, and Noad, p. 56.

[5] See *Annales de Chimie*, vol. xxxix., p. 242; *Soc. Philomathique*, an IX., p. 40; Sue, "Histoire du Galv.," vol. ii., p. 161.

[6] John Farrar, "Elem. of Elec., Mag. and El. Mag.," 1826, p. 118.

[7] See "Scientific papers of the Royal Society, vol. i., pp. 374-386; Biot's "Traité de Phys. Exp. et Math.," vol. ii., p. 457; *Journal de Physique*, vol. lix., pp. 315, 318; Wilkinson's "Elem. of Galv.," vol. ii., pp. 38, 123, 154, 361, chap. xvi; Humboldt's "Cosmos," treating of Aërolites, of the Zoodiacal Light and of the figure of the earth; Noad, "Manual," p. 530; Eighth "Ency. Brit." vol. viii., p. 580; Sir H Davy, "Bakerian Lectures," London, 1840, p. 3, alluding to Biot and Thenard in No. xl. of the *Moniteur* for 1806; "Encycl. Metropol.," vol. iv. (Electro-Magn.), p 7; Harris "Rudim. Magn.," part iii., London, 1852, pp. 116, 117; Gautherot at A. D. 1801; Figuier, "Exposition, etc.," Paris, 1857, vol. iv., p. 429; "Lib. of Useful Knowl." (Electricity), p. 64 and (Magnetism) p. 89; "Soc. Philomath.," an IX., p. 45, an XI., pp. 120, 129; Becquerel's "Traité," 1856, vol. iii. p. 11; *Phil. Mag.*, vols. xvi., p. 224, xxi., p. 382; "Mém. de l'Institut" for 1802, vol. v.; "Annales des Mines" for 1820, relative to the experiments on electro-magnetism made by Oersted, Arago, Ampère and Biot; *Phil. Mag.*, vol. xxii., pp. 248, 249, for the magnetical observations made by Biot and Arago; *Comptes Rendus* for 1839, 1 Sem., viii., No. 7, p. 223, for the observations of Biot and Becquerel on the nature of the radiation emanating from the electric spark; "Chemical News," London, 1868, vol. xvi., for John Tyndall's lecture on some experiments of Faraday, Biot and Savart; "Atti dell' Acad. de Nuovi Lincei Ann.," xv. Sess., iv. del 2 Marzó, 1862, for the biography of J. B. Biot, who died Feb. 2, 1862, within two months of the completion of his 88th year.

[8] See Bakewell, "Elec. Science," p. 40.

[9] Vol. xxiii. for 1805-1806, pp. 51-54. Extracts from a letter of Mr. Christ. Bernoulli abridged from Van Mons' *Journal*, vol. vi.

[10] *Phil. Mag.*, vol. xxiii., p. 51.

[11] See the "Encyclopædia Britannica" article relating to the influence of magnetism on chemical action, for an account of Ritter's other experiments; also Faraday's "Experimental Researches" No. 1,033; Ritter's "Physisch. Chem. Abhand., etc.," 3 vols., Leipsic, 1806; Poggendorff, vol. ii., p. 652; Tyndall's notes on Electric Polarization; Donovan's "Essay on the Origin, Progress and Present State of Galvanism," Dublin, 1816; Société Philomathique," an IV., p. 181; an IX., p. 39; an XI., pp. 128, 197; an XII., p. 145; *Bull. Soc. Phil.*, Nos. 53, 76, 79; *Nuova Scelta d'Opus.*, vol. i., pp. 201, 334; *Bibl. Brit.*, xxxi.; "Reichsanzeiger," 1802, Bd. i., No. 66, and Bd. ii., No. 194; also F. L. Augustin's "Versuch einer geschichte. . . .," 1803, p. 75; Gilbert's *Annalen*, ii., vi., vii., viii., ix., xiii., xv., xvi.; Voigt's *Magazin*, vol. ii., p. 356; Gehlen's *Journal*, vol. iii. for 1804, and vol. vi. for 1806; "Denkschr. d. Munch.," 1808 and 1814; *Phil. Mag.*, vol. xxiii., chap. ix., pp. 54, 55, for experiments from Van Mons' *Journal*, No. 17, vols. xxiv., p. 186, xxv., p. 368, lviii., p. 43; L. F. F. Creil, "Chemische Annalen" for 1801; *Nicholson's Journal*, vols. iv., p. 511, vi., p. 223, vii., p. 288, viii., pp. 176, 184; "Gottling's Almanach," for 1801; Leithead, "Electricity," p. 225; "Encycl. Metropolitana," article "Galvanism," vol. iv., p. 206; "Biographie Générale," vol. xlii., p. 322; Larousse, "Dict. Universel," vol. xiii., p. 1234; Pierre Sue, aîné, "Histoire du Galvanisme," Paris, an X., 1,802, vol. i., pp. 226, 266, vol. ii., pp. 112-119, 156; Joseph Izarn, "Manuel du

A. D. 1803.——Basse (Frédéric Henri), of Hamel, makes one of the earliest trials of the transmission of galvanism through water and soil, the results of which appear in his work, "Galvanische Versuche, etc.," published at Leipsic the year following.

Along the frozen water of the ditch or moat surrounding the town of Hamel he suspended 500 feet of wire, on fir posts, at a height of six feet above the surface of the ice, then making two holes in the ice and dipping into them the ends of the wire, in the circuit of which were included a galvanic battery and a suitable electroscope, he found that the current circulated freely. Similar experiments were made in the Weser; then with two wells, 21 feet deep and 200 feet apart; and, lastly, across a meadow 3,000 to 4,000 feet wide. Whenever the ground was dry it was only necessary to wet it in order to feel a shock sent through an insulated wire from the distant battery. Erman, of Berlin, in 1803, Sömmerring, of Munich, in 1811, performed like experiments, the one in the water of the Havel, near Potsdam, and the other along the river Isar.

Fahie, from whom we take the above, alludes to Gilbert's *Annalen der Physik*, vol. xiv., pp. 26 and 385, and to Hamel's "Historical Account," p. 17, of Cooke's reprint, and adds that Fechner, of Leipsic, after referring to Basse's and Erman's experiments in his "Lehrbuch des Galvanismus," p. 268, goes on to explain the conductibility of the earth in accordance with Ohm's law. As he immediately after alludes to the proposals for electric telegraphs, he has sometimes been credited with the knowledge of the fact that the earth could be used to complete the circuit in such cases. This, however, is not the fact, as we learn from a letter which Fechner addressed to Prof. Zetzsche, on the 19th of February, 1872.[12]

A. D. 1803.——Thillaye-Platel (Antoine), French savant, who was afterward appointed pharmacist in the Paris *Hotel-Dieu*, gives out as the result of numerous investigations a great many useful precepts on the medical application of electricity and galvanism, which will be found in his thesis presented to the Paris Ecole de Médecine on the 15th Floréal, an XI. These precepts, De La Rive says,[13] are followed to this day and are extremely simple, requiring only the use of metallic brushes held by an insulated handle and put into communication with the conductor of the machine, and directing the application of electricity in its mildest form as well as its gradual increase to as much as the invalid is able to support, besides allowing of the concurrent employment of other means acting in the same direction, such as frictions, blisters, etc.[14]

Antoine Thillaye-Platel's uncle, Jean Baptiste Jacques Thillaye (1752-1822), French physician and professor of anatomy at Rouen and in Paris, published "Elements de l'Elect. et du Galv.," Paris, 1816–1817, ten years after the death of his nephew.[15]

De La Rive alludes to cures effected by several special ists and particularly to Father R. B. Fabre-Palaprat's translation made in 1828 of La Beaume's English work on the medical efficacy of electricity and galvanism, originally published in 1820-1826. The latter, he says, is preceded by a preface wherein the translator rivals the author on the wonderful effects of the electric fluid as a sovereign remedy for about all maladies.[16]

Galvanisme," Paris, an XII., 1804, pp. 84-87. 249, 255-261; Brugnatelli, "Notizie . . . nell," anno 1804. Pavia. 1805, p. 16, also his *Annali di chimica*. vol. xxii , p. 1; *Journal de Physique*, vol. lvii., pp. 345, 406; *Annales de Chimie*, vols. xli., p. 208; lxiv., p. 68; *Jour. de Chim. de Van Mons*, No. xiv., p. 212. for the experiments of Van Marum and Oersted, made with Ritter's apparatus; Sturgeon's "Scientific Researches." Bury, 1850, pp. 7, 8, and Prof. Millin's "Magasin Encyclopédique."

[12] Zetzsche's "Geschichte der Elektrischen Telegraphie," p. 19. See Dr. Turnbull's Lectures in the *Journal of the Franklin Institute*, vol. xxi., pp. 273-274; "Scientific Papers of the Royal Society," vol. i., p. 203.

[13] "Treatise on Elect.,' translated by C. V. Walker, London, 1858, vol. iii., pp. 557, 588.

[14] For Mr. Thillaye's experiments with Mr. Butet on galvanic electricity, made at the Paris Ecole de Médecine, see the *Bulletin des Sciences de la Soc. Philom.*, No. 43, also, vol. ix., p. 231, of the "Recueil Périodique de la Soc. Libre de Médecine du Louvre." Consult, likewise. Poggendorff, vol. ii., p. 1,094; "Royal Society Catalogue of Scientific Papers," vol. v., p. 954; De La Rive's "Treatise," vol. iii., pp. 587, 588; P. Sue, aîné, "Histoire du Galvanisme," vol. iii., p. 14.

[15] Poggendorff, vol. ii., p. 1,094; Larousse, "Dict. Univ.," vol. xv., p. 131.

[16] Some of the other authors who have treated of the same subject are: F. Zwinger, 1697-1707; W. B. Nebel, 1719; Oppermanno. 1746; E. Sguario. 1746; G. C. Pivati, 1747-1750; G. Veratti, 1748-1750; O. de Villeneuve. 1748; L. Jallabert. 1748-1750; G. F. Bianchini, 1749; Mellarde, of Turin. 1749; Palma. 1749; F. Sauvages de la Croix, 1749-1760; J. B. Bohadsch. 1751; O. M. Pagani. 1751; S. T. Quellmaz, 1753; A. von Haller, 1753-1757; Linné (Linnæus), 1754; P. Paulsohn, 1751; E. F. Runeberg, 1757; P Brydone. 1757; Lower, 1760; De Lassone, 1763; Wm. Watson, 1763; G. F. Hjotberg, 1765; J. G. Teske. 1765; P. A. Marrherr, 1766; Gardane. 1768-1778; J. G. Krunitz, 1769; R. Symes, 1771; Sigaud de la Fond, 1771; C. A. Gerhard. 1772; Abbé Sans, 1772-1778; J. Janin de Combe Blanche, 1773; J. B. Becket, 1773; Marrigues à Montfort L'Amaury, 1773; G. F. Gardini. 1774; J. G. Schaffer, 1776; Mauduyt, 1776-1786; De Thouri, 1777; A. A. Senft. 1778; Masars de Cazéles. 1780, 1788; P. F. Nicolas, 1782; Bonnefoy. 1782; Niccolas, 1783, K. G. Kuhn. 1783, 1797; C. W. Hufeland, 1783; Cosnier, Maloet. Darcet. etc., 1783; J. P. Marat. 1784; G. Vivenzio, 1784; Carmoy, 1784-1785; G. Piccinelli. 1785; L. E. de Tressan "Essai . . ." 1786, p. 233, etc.; Krunitz-Kirtz, 1787; Porna and Arnaud, 1787; F. Lowndes. 1787-1791; J. H. D. Petetin, 1787, 1808; G. Pickel, 1788; Van Troostwijk and Krayenhoff. 1788; R. W. D. Thorp, 1790; G. Wilkinson, 1792; C. H. Pfaff. 1793; G. Klein, 1794; M. Imhof, 1796; C. H. Wilkinson. 1799; C. A. Struve, 1802; Maurice, 1810; J. Morgan, 1815; Le Blanc, 1819; P. A. Pascalis, 1819; J. Price, 1821; K. Sundelin, 1822; Girardin, 1823; Ch. Bow, 1824; Sarlandière, 1825; S. G. Marianini. 1833; F. Puccinotti. 1834; Francois Magendie, 1836, 1837; Gourdon, 1838; C. Matteucci, Piria, etc., 1838. 1858; Breton Frères. 1844; B. Mojon. Jr., 1845; J. E. Riadore, 1845; A. Restelli, 1846; Budge. 1846; F. Hollick, 1847; R. Froriep, 1850; C. V. Rauch, 1851; H. Valerius, 1852; Burci, 1852; Marie-Davy, 1852-1853; W. Gull. 1852; C. Beckensteiner, 1852-1870; F. Channing, 1852; F. F. Videt. 1853; R. M. Lawrance. 1853-1858; G M. Cavalleri, 1854, 1857; Briand. 1854; M. Kierski, 1854; P. Zetzell, 1856; Ad. Becquerel, 1856-1860; E. Pfluger, 1856, 1858; Pulvermacher, 1856: P. C. Pinson. 1857; H. Ziemssen, 1857-1866; Philipeaux. 1857; J. Dropsy, 1857; M. Meyer, 1857-1869; Nivelet, 1860-1863; A. Tripier, 1861; J. Rosenthal, 1862; Desparquets. 1862; M. P. Poggioli (Mémoire lu à l'Institut. Oct. 31. 1853; "Annal of Scientific Disc.," 1865, page 327); G. Niamias, "Della elettr . . . medicina," 1851 ("An. of Sci. Dis.," 1865, p. 327); A. C. Garrat. 1866; H. Lobb. 1867; Aug. Beer. 1868; H. M. Collis ("An. of Sci. Dis.," 1869. p. 175); Toutain, 1870; J. R. Reynolds, 1872; Onimus and Legros. 1872; as well as Jobert de Lamballe, Richter and Erdmon. T. Guitard, J. J. Hemmer, H. van Holsbeek, T. Percival, J. D. Reuss and Mr. Ware (in Kuhn, Hist. ii., p. 183).

Equivalent Resistance, Self-Induction and Capacity of Parallel Circuits with Harmonic Impressed Electromotive Force.*

BY FREDERICK BEDELL, PH.D., AND ALBERT C. CREHORE, PH.D.

In a paper on "Forced Harmonic Oscillations of Various Periods," in the *Philosophical Magazine* for May, 1886, Lord Rayleigh derived analytically expressions for the equivalent resistance and self-induction of parallel circuits in terms of the resistance and self-induction of each branch. The object of this paper is to obtain by other methods similar expressions for the equivalent resistance, self-induction and capacity of any number of parallel circuits in terms of the resistance, self-induction and capacity of each branch. From these general results particular expressions for the case of circuits with resistance and capacity alone, and for the case of circuits with resistance and self-induction alone, are readily derived. The results in this latter case are identical with those given by Lord Rayleigh in the paper referred to.

Resistance is denoted by R, self-induction by L, capacity by C, and equivalent resistance, self-induction, and capacity by R', L' and C' respectively. The currents (maximum value) in the main line and branches are denoted by I_m, and by I_1, I_2, etc.

θ is the angle of advance or lag according to whether it

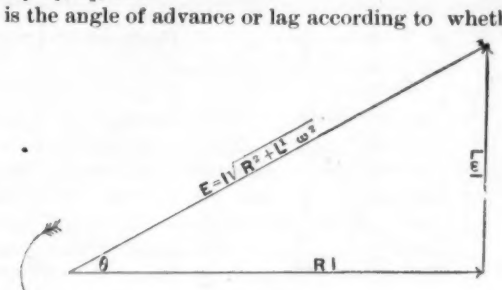


Fig. 1.

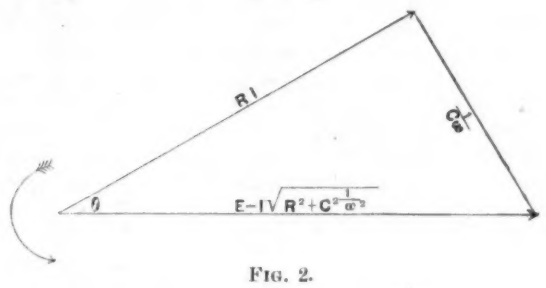


Fig. 2.

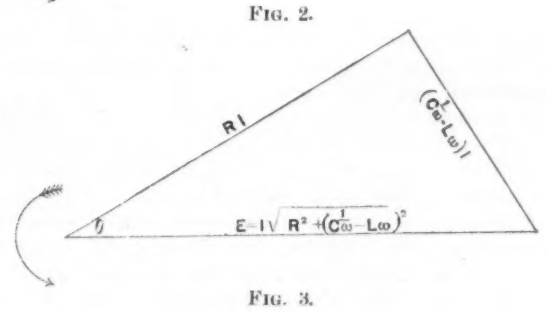


Fig. 3.

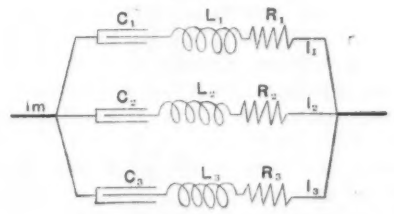


Fig. 4.

is positive or negative. ω is the angular velocity, *i. e.*, $2\pi \times$ frequency, and E the maximum value of the impressed electromotive force.

Figs. 1 and 2 are triangles of E. M. Fs. for simple circuits with resistance and self-induction, and resistance and capacity respectively. Rotation is in all cases counter clockwise and the impressed E. M. F. is considered as the sum of that necessary to overcome the resistance and self-induction or capacity. Fig. 3 is the E. M. F. triangle for a single circuit with resistance, self-induction and capacity, the current being in advance of the impressed E. M. F. in this particular case, in which $\frac{1}{C\omega}$ is taken as greater than $L\omega$.

In Fig. 5, OBA, OCA, ODA are the E. M. F. triangles for the several branches of a divided circuit (see Fig. 4), with an impressed E. M. F. equal to $\overline{OA}$. The main current, I_m, is the vector sum of the currents I_1, I_2, I_3 in the branches. By taking the projections of the currents upon the line $\overline{OA}$, and then upon a line perpendicular to $\overline{OA}$, we obtain the equations

$$I_m \cos\theta = I_1 \cos\theta_1 + I_2 \cos\theta_2 + \ldots = \Sigma I \cos\theta. \quad (1)$$

$$I_m \sin\theta = I_1 \sin\theta_1 + I_2 \sin\theta_2 + \ldots = \Sigma I \sin\theta. \quad (2)$$

In the right triangle OFA,

$$I_m = \frac{E}{\sqrt{R'^2 + \left(\frac{1}{C'\omega} - L'\omega\right)^2}} \quad (3)$$

$$\cos\theta = \frac{R'}{\sqrt{R'^2 + \left(\frac{1}{C'\omega} - L'\omega\right)^2}} \quad (4)$$

$$\sin\theta = \frac{\frac{1}{C'\omega} - L'\omega}{\sqrt{R'^2 + \left(\frac{1}{C'\omega} - L'\omega\right)^2}} \quad (5)$$

* From the *Philosophical Magazine*, London.

Substituting in (1) and (2) these values, and similar values for I_1, $\cos\theta_1$, $\sin\theta_1$; and I_2, $\cos\theta_2$, $\sin\theta_2$, etc., we have

$$\frac{I_m \cos\theta}{E} = \frac{R'}{R'^2 + \left(\frac{1}{C'\omega} - L'\omega\right)^2} = \sum \frac{R}{R^2 + \left(\frac{1}{C\omega} - L\omega\right)^2} = A \quad (6)$$

$$\frac{I_m \sin\theta}{E} = \frac{\frac{1}{C'\omega} - L'\omega}{R'^2 + \left(\frac{1}{C'\omega} - L'\omega\right)^2} = \sum \frac{\frac{1}{C\omega} - L\omega}{R^2 + \left(\frac{1}{C\omega} - L\omega\right)^2} = \sum \frac{C - C^2 L\omega^2}{C^2 R^2 \omega^2 + (1 - CL\omega^2)^2}\omega = B\omega \quad (7)$$

The letters A and B are introduced to simplify the results. Dividing (7) by (6),

$$\tan\theta = \frac{B\omega}{A} \quad (8)$$

Comparing (4) and (6), we obtain

$$A = \frac{\cos^2\theta}{R'} \text{ or } R' = \frac{\cos^2\theta}{A}$$

Comparing (5) and (7), we obtain

$$B\omega = \frac{\sin^2\theta}{\frac{1}{C'\omega} - L'\omega}; \text{ or } \frac{1}{C'\omega} - L'\omega = \frac{\sin^2\theta}{B\omega} \quad (10)$$

For $\cos^2\theta$ and $\sin^2\theta$ we may substitute the values

$$\text{Cos}^2\theta = \frac{1}{1 + \tan^2\theta} = \frac{1}{1 + \frac{B^2\omega^2}{A^2}} = \frac{A^2}{A^2 + B^2\omega^2}$$

$$\text{Sin}^2\theta = \frac{1}{1 + \cot^2\theta} = \frac{1}{1 + \frac{A_2}{B^2\omega^2}} = \frac{B^2\omega^2}{A^2 + B^2\omega^2}$$

With these substitutions equations (9) and (10) become

$$R' = \frac{A}{A^2 + B^2\omega^2}. \quad (11)$$

$$\frac{1}{C'\omega} - L'\omega = \frac{B\omega}{A^2 + B^2\omega^2}. \quad (12)$$

Here A and $B\omega$ each stand for a summation, as expressed in (6) and (7), and are calculated from the particular values of the resistance, self-induction and capacity of each branch This gives a definite value to the equivalent resistance, R', according to (11), and a definite value to $\frac{1}{C'\omega} - L'\omega$, according to (12). There may be an indefinite

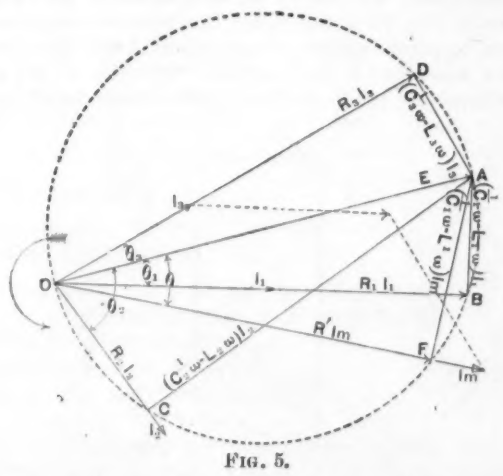


Fig. 5.

number of values assigned to L' or C' according to values assigned to the other. If the right-hand member of (12) is positive, we may consider that the equivalent circuit has no self-induction, *i. e.*, $L' = 0$, and calculate the equivalent capacity. If this member is negative, we may consider that the equivalent circuit has no condenser, *i. e.*, $C' = \infty$, and calculate accordingly the equivalent self-induction. The angle of advance or lag of the main current is obtained from equation (8).

If there is no condenser in any branch, the expressions for A and $B\omega$ are obtained by substituting $C = \infty$ in the summations in (6) and (7), thus

$$A = \Sigma \frac{R}{R^2 + L^2\omega^2},$$

and

$$B\omega = \Sigma \frac{-L\omega}{R^2 + L^2\omega^2}$$

Equations (11) and (12) with these values for A and $B\omega$ give the equivalent resistance and self-induction of parallel circuits containing resistance and self-induction only. These expressions are the same as those obtained by Lord Rayleigh.

If there is no self-induction in any branch, the substitution of $L = 0$ in (6) and (7) gives

$$A = \Sigma \frac{R}{R^2 + \frac{1}{C^2\omega^2}},$$

and

$$B\omega = \Sigma \frac{\frac{1}{C\omega}}{R^2 + \frac{1}{C^2\omega^2}} = \Sigma \frac{C\omega}{C^2R^2\omega^2 + 1}.$$

With these values, equations (11) and (12) give the equivalent resistance and capacity of parallel circuits containing resistance and capacity only.

Physical Laboratory of Cornell University, July, 1892.

The Measurement of Hysteresis and Eddy Current Losses in Transformers.—I.

BY SYDNEY EVERSHED AND ERNEST B. VIGNOLES.

In our first article* we have described a method by which the loss of power in the core of a transformer may be measured by the rise of its temperature; and the first application we made of it, namely, to determine whether a cross-induction, applied to an alternately magnetized ring, diminished the loss by hysteresis, gave such exceedingly concordant results as to enable us to determine within very narrow limits the waste of energy in an iron core; and we therefore determined to use the method for a preliminary investigation of the subject of viscous hysteresis.

This is a subject which has long engaged the attention of physicists, but we found the current ideas on the subject in a somewhat nebulous condition. Profs. Ayrton and Perry, in their Motor paper of 1883, came to the conclusion that they had distinct evidence in the displacement of the field in a motor of the existence of viscous hysteresis to a very appreciable extent; and to this view they have always adhered. Others, however, have denied the existence of viscous hysteresis of an appreciable amount, explaining the professors' results as effects of armature reactions and eddy currents in the core.

The first evidence which was published on the subject, so far as we know, was the experiments of that indefatigable worker in this field, Prof. Ewing, who showed that when iron was subjected to weak magnetizing forces, the amount of induction continued to increase for some minutes after the application of the force.

But before this, other experiments on this subject had been made by Mr. C. J. Barley at the Central Institution, in which a ring of iron was rotated above the poles of an electromagnet, in the field of which a permanent magnet hung with its poles immediately over the rotating ring. Eddy currents were eliminated as far as possible by lamination, and air currents by suitably screening the suspended needle; and the result was to show that in addition to the displacement in the field caused by static hysteresis when the ring was slowly turned, there was a further displacement in the same direction when the ring was rotated at speeds corresponding to a frequency of about 100 ~ per second or more; and Mr. Barley attributed this to viscous hysteresis. The experiments do not appear to have led to quantitative results, and can hardly be regarded as conclusive.

Theoretically it would appear probable that as even molecules must have some inertia, time must be taken to move them; but it was obviously a question whether in a transformer worked by an alternator at, say 100 ~ per second, the time taken for the induction to pass from zero to its maximum value—about 1-400 of a second—was enough to make a serious difference in the amount of induction produced by a given magnetizing force.

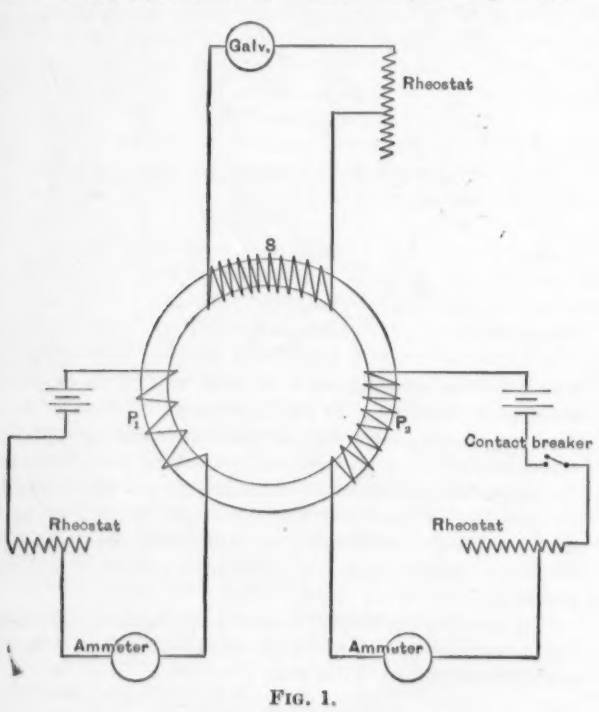


Fig. 1.

Prof. Ryan, whose curves from actual transformers would have been the most valuable practical contribution to the subject ever published had he given full details and dimensions of the transformers used,† gave in his paper a curve of losses in his iron in which eddy currents were included with hysteresis. This curve may be seen in the articles on transformers by one of the authors in "The Electrician;" ‡ and Prof. Ryan, comparing this curve with Ewing's, concluded that there "was no room for viscous hysteresis." He, however, appears to assume that his iron was identical in quality with that tested by Prof. Ewing, a somewhat unwarrantable assumption, as we shall presently show.

Such was the state of our knowledge of the subject when in March, 1891, we made a discovery which gave us some hope of finally settling the question.

In order to explain this clearly, it is necessary to refer to the paper read by one of the authors in May, 1891, to the Old Students' Association of the City and Guilds of London Institute.* A very full description of our method of testing iron is given in this paper, to which we may refer any one who cares for fuller information. Briefly the arrangement is this:

The ring of iron is wound with two superposed primaries, in one of which, P_1, a constant current is maintained; in the other, P_2, a magnetizing force is produced in the reverse direction; so that by making and breaking this circuit the iron can be carried practically instantaneously through an induction cycle, starting from and returning to the lowest point of the curve. Now by consulting Fig. 2 it will be seen that observations on the rising curve can be taken by simply making a current in P_2, thus obtaining the ordinates *AB*, *CD*, etc.; and since our galvanometer takes about one second to make its swing, its period being 3.8 seconds, it follows that all the observations on the rising curve give the integral of the induction up to one second after the application of the magnetizing force.

Not so with the falling curve. In order to get on to this curve, it is necessary to put on the current P_2 at its

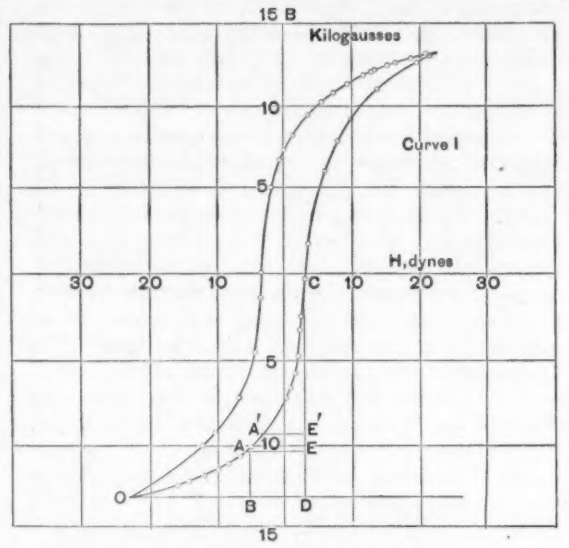


Fig. 2.—Method of Obtaining Ordinates of Cyclic Curve.

maximum value, decrease to the value required, wait to read the ammeter (these operations taking perhaps half a minute), and then break.

Consequently, if the induction lags in time behind the magnetizing force, it has time to creep down during these processes, and we should naturally expect it to creep most at the steep parts of the curve; therefore, the net result should be a difference in shape between the rising and falling curves; the falling curve being more perpendicular to the axis of **H** than the other, and inclosing less area. This consideration was forced upon us by the study of our curves, in many of which this phenomenon is most noticeable. In the paper read to the Old Students' Association, already referred to, the cause was hinted at; but as we then had no further evidence, we had not the confidence in the explanation which we now possess.

The difference between the work done if the induction were forced through its cycle in about two seconds and that which would be done if the time taken were very large is considerable. The curve given here, Fig. 3, is a good instance.

The full line is the curve when the integral of the induction up to one second after the application of the magnetizing force is taken as the ordinate, while the dotted line shows the area when a comparatively long time, perhaps half a minute, is allowed to elapse between the application of the force and the measurement of the amount of induction. The difference in the areas amounts to 19% of the smaller curve. It will be understood that this particular curve is an extreme case; but it is noticeable that all our curves give losses larger than those given for similar materials in Prof. Ewing's tables.†

All curves except ours have been taken by static methods‡ which would give the area of the dotted curve; and if the difference between the work done in the two cases mentioned is so great, why should it not be far greater when the time occupied is only 1-100th part of a second? Indeed it seemed highly probable that the difference might be very considerable, and preliminary experiments had led us to anticipate that a difference of 50% was not unlikely. Obviously to determine the point it was necessary to measure the power wasted when the transformer was run on an alternating current, and compare it with the loss when put through the same cycle comparatively slowly.

That such a comparison is not without commercial value the following considerations will show. The number of lamps on the circuits of the alternate current supply companies in London alone must exceed the equivalent of 120,000 thirty-watt lamps. The transformers running these are mostly small in size, and it takes at least 5% of their full load output to excite them; hysteresis losses being responsible for 80% of this. The money value of this power—170 units per hour—to the supply companies, cannot be less than £10,000 a year, money which is being absolutely thrown away, and any inquiry into the causes of this waste cannot but be of commercial importance. Observe that in this calculation the efficiency of the transformers has been based on the assumption that the static curve gives the hysteresis loss; it follows, therefore, that if there were an additional waste amounting to anything like 50%, another £5,000 at least would have to be added to the above figure. But, apart from this, the question is one of considerable scientific interest.

We will now proceed to describe the experiments by which the point may be settled. The first and most satisfactory method is the use of a wattmeter. If the back electromotive force of the pressure coil is kept very low, and no metal in any part of the instrument is allowed to produce eddy current errors, the method is, of course, perfectly accurate. Such a wattmeter, however, takes time to construct, and we were impatient to have some information on the subject; we therefore determined to make preliminary experiments by the thermometric method.

The process was as follows: The actual rate of rise of temperature, corrected for cooling, was determined, and then compared with the rise predicted from the following data:

(1.) The area of the **B H** curve taken from the actual piece of iron used.

This gives the watts spent in hysteresis, when the iron is going through its cycle once in about two seconds.

(2.) The watts spent in eddy currents in the iron from the mean induction density. This waste is so small compared with the amount of energy lost by hysteresis that no elaborate mathematical treatment is required.

From 1 and 2 we get the rate of conversion of energy into heat.

The specific heat of the transformer should also be determined, and we are then in a position to predict the rate of heating—when no cooling takes place—and on the assumption that the area of the **B H** curve is the same for such widely different frequencies as 100 ~ per second and 0.5 ~ per second. Any difference between predicted and observed effects may be set down to viscous hysteresis.

THE TRANSFORMER.

The transformer was built up of twenty charcoal iron circular stampings, the inner diameter of which was 4.15 cm., outer diameter 9.25 cm. The mean thickness of each stamping from 40 measurements was .0414 cm. Embedded in the core thus formed was the bulb of a clinical thermometer, having a range of 10°—35° C. in tenths of degrees, and capable of being easily read to 0.025° C.

A secondary circuit of 300 turns was wound evenly all round the ring for the purpose of measuring the induction in conjunction with a Cardew voltmeter. The primary winding consisted of one straight cable, on which the transformer was threaded, without touching it at

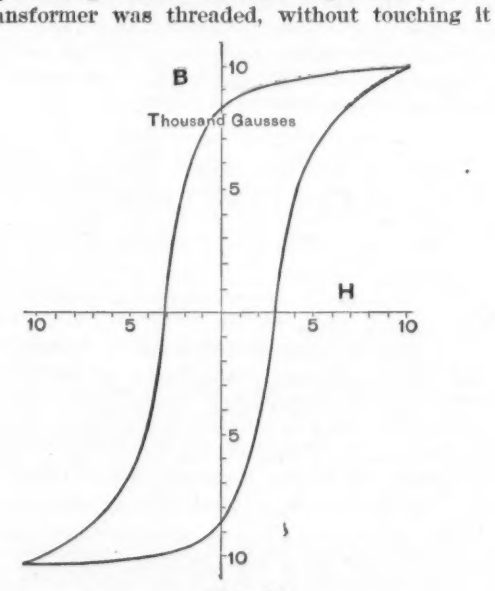


Fig. 3.*

any point. The idea of this precaution was to render the heating due to $C^2 R$ in this cable of as little importance as possible.

The following table contains complete dimensions, etc., worked out from the above data:

Transformer.

Area of section across induction path	= 2.12 sq. cm.
Average length of induction path	= 21.02 cm.
Volume of iron	= 44.55 cc.
Weight of transformer including secondary	= 377 grammes.
Secondary circuit	= 300 turns.
" resistance	= 7.5 ohms.
Resistance of Cardew voltmeter	= 55 ohms.
Effective E.M.F. in secondary circuit	= Reading of Cardew + $\frac{(55 + 7.5)}{55}$

MEASUREMENT OF SPECIFIC HEAT OF TRANSFORMER

Since the specific heat of iron is known to lie between 0.11 and 0.12, it was easily determined with sufficient accuracy in the following manner: The transformer was heated to 100°C., and the total rise of temperature produced by immersing it in a vessel containing a certain weight of water at a known initial temperature was compared with that produced by a known weight of

The Electrician, vol. xxxvii., p. 661, Oct. 15, 1896.
*Why *do* people invariably leave out the most essential information?
†Vol. xxvi., p. 724, April 17, 1891.

The Electrician, vol. xxvii., p. 50, May 15, 1891.
†Vide *The Electrician*, vol. xxvi., p. 614, March 20, 1891.
‡Since this was written Dr. Hopkinson has become a convert.

*As no names have yet been given to the units, we have been compelled to invent our own:
1 Thom = 1 C. G. S. unit of induction.
1 Gauss = 1 Thom per sq. cm.

boiling water when mixed in the same vessel with the same amount of cooling water at nearly the same initial temperature. Since we know that somewhere about 0.11 of the weight of transformer must be the weight of the water added to obtain the same rise of temperature, the two experiments are easily made practically identical as regards cooling; the same vessel being used and the air temperature being constant.

The transformer, being built of iron plates insulated with thin paper, naturally carried over from the bath in which it was heated a considerable amount of water; and it is in the weight of water occluded that the greatest chance of variation occurs. Several measurements, however, showed that the variations in weight, on lifting the transformer from the water bath, were within the limits of accuracy required.

Put algebraically, if

w = weight of dry transformer,
v = " " water occluded,
W = " " " in cooling vessel
g = " " " used for comparison in second experiment.
x = specific heat of transformer,
y = " " " water,
T = initial temp. of transformer
i = " " " bath..... } in Expt. I.,
t = final temp. of iron and bath
T = initial " of water used for comp's'n
J = " " " bath ..... } in Expt. II.,
θ = final temp. of both..... ....
q = heat lost by radiation and convection from bath,

then the equation

Total heat before immersion = total heat after immersion + quantity lost, or—

$$w\,x\,T + v\,y\,T + W\,y\,i = w\,x\,t + v\,y\,t + W\,y\,t + q \quad (1)$$

represents the result of the first experiment, the second experiment being of course necessary to eliminate q.

The corresponding equation for the second experiment is—

$$g\,y\,T + W\,y\,j = g\,y\,\theta + W\,y\,\theta + q \quad (2)$$

Since the conditions as to cooling during the rise of

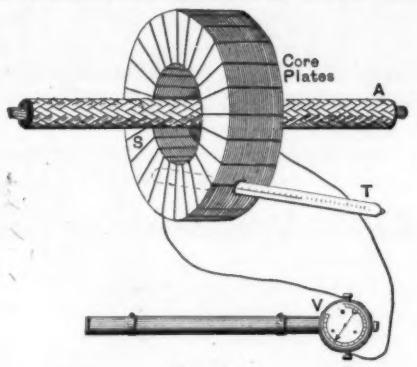


FIG. 4.

temperature of the bath are practically identical, no appreciable error can be caused by assuming the quantity of heat lost, q, to be the same in both experiments.

Eliminating q from equations (1) and (2), and writing $y = 1$, we find the value of specific heat of the transformer compared with water, viz.:

$$x = \frac{W(t-i) + g(T-\theta) - W(\theta-j) - v(T-t)}{w(T-t)} \quad 3)$$

Substituting the following values in this equation:

W	= 10,630 grains	T	= 100° C.
g	= 1,080 "	i	= 12.7° C.
v	= 675 "	t	= 21.4° C.
w	= 5,815 "	j	= 12.2° C.
		θ	= 19.3° C.

we arrive at the value

$$x = 0.112 \text{ gramme degree centigrade.}$$

Remembering that 4.2 joules = 1 gramme degree centigrade, we find the specific heat of the transformer to be

$$4.2 \times 0.112 = 0.47 \text{ joules.}$$

It is evident, therefore, that the insulating tape and paper and the copper secondary circuit have practically no effect on the value of the specific heat, which is generally given in text books at 0.112 for soft iron.

The transformer was then taken to pieces, dried and rebuilt, experiment I. having reduced it to a sloppy mass.

MEASUREMENT OF WASTE POWER.*

The order of procedure was as follows: Having previously calculated the volts on the Cardew which would be produced by a maximum induction density of 10,000 gausses,† the primary current was started and raised as rapidly as possible to a value giving the required reading on the voltmeter. We may note that this adjustment must be made exceedingly quickly, as the range of the thermometer is short and the whole of the heating curve is taken in less than 10 minutes.

Observations are taken by two experimenters of the times at which the transit of the mercury over each degree of the scale takes place; while a third keeps the speed of the alternator constant; a small adjustment being made from time to time of the primary current as the circuits rise in temperature.‡ When the thermometer is about to reach the top of its scale, the primary and secondary currents are rapidly replaced by direct currents of the same effective value; and time readings of the thermometer are taken as the transformer cools. As the rate of cooling depends on the difference of temperature between the transformer and the air, frequent observations must be made of the air temperature in the neighborhood.

It may not be without interest to compare this method with other thermometric methods which have been used or proposed for the purpose. Mr. Mordey attempted to determine the final temperature, and to do this he had to maintain the power supplied to the transformer and the frequency constant for many hours, encountering additional difficulties in the variation of the temperature of

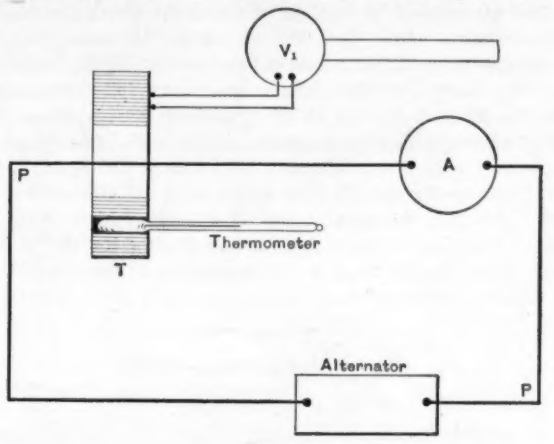


FIG. 5.

the air and surrounding objects, accentuated by the use of a "shilling thermometer." Prof. Ewing, on the other hand, has suggested* the use of a thermo-electric couple in place of the thermometer, but we should anticipate difficulties from currents induced in the thermoelectric circuit. Mr. Alex. Siemens has recently published some measurements of the power wasted in a transformer core, determined from observations of two temperatures, giving two points on the curve corresponding to our curve J; thus making a great advance on the somewhat crude method of observing final temperatures. The method we used, similar in principle, gives however ten or twenty points on the curve in the space of ten minutes, the discrepancy of these affording an excellent criterion of the accuracy of observation. Moreover, the use of an accurate thermometer gives the temperature without further complication, and it is much easier to determine a number of times by the observation of the transit of the mercury over successive divisions than by measurement of a series of resistances.

Fig. 4 is a perspective view of the arrangement we adopted, the circuits being arranged as shown in Fig. 5. The transformer in the present case is laminated in the plane of the ring, and not as shown in Fig. 5.

EXPERIMENT II.—HEATING AND COOLING CURVES.

(*a*) *Heating.*—Frequency = 100 ~. Secondary volts on voltmeter = 24.8. Air = 15° C. Primary current = 198 ampères.

Time. H. M. S.	Temperature of transformer. °C.	Time. H. M. S.	Temperature of transformer. °C.
5 28 1	22	5 32 27	29
5 29 12	24	5 33 9	30
5 29 48	25	5 33 55	31
5 30 27	26	5 34 45	32
5 31 5	27	5 35 33	33
5 31 45	28	5 36 24	34

(*b*) *Cooling.*—Secondary and primary currents replaced by direct.

Time. H. M. S.	Temperature. °C.	Time. H. M. S.	Temperature. °C.
5 38 46	33.5	5 52 47	28.0
5 39 25	33.0	5 54 55	27.5
5 41 6	32.0	5 58 45	27.0
5 43 18	31.0	6 4 4	26.5
5 44 33	30.5	6 9 55	26.0
5 45 50	30.0	6 36 0	25.25
5 47 11	29.5	6 37 40	25.0
5 48 54	29.0	6 40 50	24.0
5 50 47	28.5	6 44 12	23.0

The results of experiment II. are plotted in Fig. 6 where O is the heating curve, C the cooling curve. When the

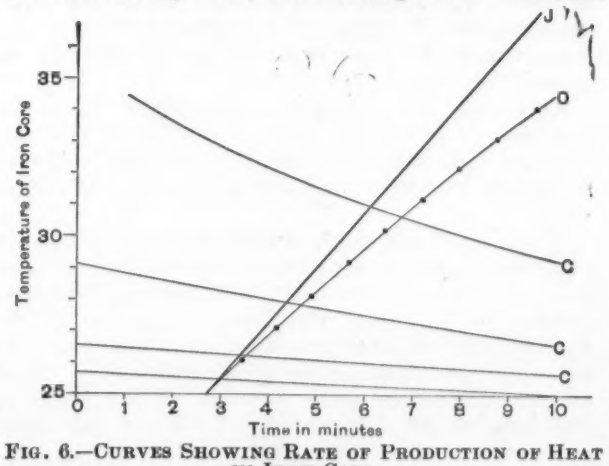


FIG. 6.—CURVES SHOWING RATE OF PRODUCTION OF HEAT IN IRON CORE.

O. Observed rise of temperature. *C.* Cooling curve. *J.* Corrected rise of temperature.

former is corrected for cooling in the manner described in our first article the curve J is obtained, indicating the rate of heating which would take place if no cooling occurred; in other words, the rate of conversion of energy in the core of the transformer.

The power spent in the core (in watts) is obtained from J in the following manner:—Experiment I. shows that the work required to raise 1 gramme of transformer 1°C. is 0.47† joules.

Multiplying this into the weight of the transformer, viz., 377 grammes, gives 177 joules required to raise the transformer 1°C. The rise from curve J is found to be 0.0305° C. per second; and, therefore, the number of joules per second (watts) converted into heat is 177 × 0.0305, or 5.4 watts.

(To be continued.)

Recent Tests of Incandescent Lamps.

The following reply to the circular* sent out by Messrs. Siemens & Halske, for which we are indebted to "Electricity" (London), has been issued by the "Electricitats Meatschappy System de Khotinsky in Gelnhausen:"

Circulars have lately been sent out from Berlin with the object of creating distrust of incandescent lamps consuming less energy than those hitherto in general use, and, by publishing the results of measurements, to furnish an apparent proof that, under the given circumstances, a saving by the employment of such lamps is out of the question.

In the published tests, only lamps of 1½, 2 and 2½ watts per candle have been considered, and the results, as regard decrease of candle power, and increase of consumed energy, have been represented in such a way as if these two defects were confined to 1½, 2, and 2½ watt lamps.

This is incorrect and misleading. All incandescent lamps, whatever their consumption of energy, and whatever their candle power, are subject, in practical use, to a decrease in candle power, and an increase in consumed energy.

If we want correctly and fairly to establish the efficiency of glow lamps consuming less energy than those hitherto in general use, we must determine the relative decrease of candle power and increase of energy of these lamps compared with those in common use.

The following are the results of comparative tests of this kind:

On the 8th of June we inserted in the same circuit:

(a) Fifteen glow lamps of a large Berlin firm, marked 16 candles at 100 volts, and 3½ watts per candle.

(b) Fourteen glow lamps of our own make of 100 volts, 16 candles and 2.6 watts per candle.

The measurements carefully taken showed the following results:

(a) The Berlin lamps (3.7 watts) at 100 volts constant E. M. F. consumed after:

140 hours, 15.50 candles, 3.92 watts per candle.
300 " 12.87 " 4.51 " " "
550 " 8.95 " 6.32 " " "

(b) Lamps of our own make, after:

120 hours, 13.00 candles, 3.14 watts per candle.
210 " 10.55 " 3.75 " " "
400 " 8.35 " 4.33 " " "
500 " 8.57 " 4.51 " " "

The life of the lamps was as follows:

(a) The 15 Berlin lamps (3.7 watts).

1 lamp was extinguished after 20 hours.
1 " " " " 208 "
1 " " " " 295 "
1 " " " " 332 "
1 " " " " 386 "
1 " " " " 552 "

(b) The 14 lamps of our own make (2.6 watts).

1 lamp was extinguished after 300 hours.
1 " " " " 565 "

After 600 burning hours had been reached, the normal E. M. F. through a mistake of the engineer-in-charge was for a moment considerably exceeded.

There was destroyed by this mishap:

(a) 7 of the Berlin lamps (3.7 watts).

(b) 10 of our own lamps (2.6 watts).

There was left burning after 600 hours, and are still burning after 1,200 hours:

(a) 2 of the Berlin lamps (3.7 watts).

(b) 2 of our lamps (2.6 watts).

These lamps, on being carefully tested, gave the following results:

(a) 2 Berlin lamps at 100 volts, after 1,000 hours, 3.85 candles, 13.0 watts per candle.

(b) 2 of our own lamps at 100 volts, after 1,000 hours, 6.4 candles, 5.64 watts per candle.

These tests show that at the commencement of burning the relative decrease of candle power and increase of energy of the 3.7 watt lamps are more favorable than those of the 2.6 watt lamp.

The longer the burning hours, however, the more is this proportion modified. The decrease of candle power and increase of consumed energy of the 3.6 watt lamp grew much more rapidly than those of the 2.6 watt lamp. At 550 or 500 burning hours their proportion is in favor of the 3.7 watt lamp only by 2½%, while it is distinctly in favor of the latter at 1,000 burning hours.

We, therefore, find

DECREASE OF CANDLE POWER.

(a) Of the Berlin (3.7 watts) lamp, in 550 burning hours, 7.05 candles = 44% (16 candles at the commencement, against 8.95 candles after 550 burning hours).

(b) Of our own (2.6 watts), in 550 burning hours, 7.43 candles = 46½% (16 candles at the commencement, against 8.57 candles after 550 burning hours).

INCREASE OF CONSUMED ENERGY.

(a) Of the Berlin lamp (3.7 watts), in 550 burning hours, 2.62 watts per candle = 71% (3.70 watts at the commencement, against 6.32 watts after 550 burning hours).

(b) Of our own lamp (2.6 watts), after 500 burning

The Electrician, vol. xxvii., p. 664, Oct. 15, 1891.

†Our "gauss" is 1 thom per sq. cm., and has no connection with the gauss of Dr. Fleming; and less still with that of Mr. Oliver Heaviside.

‡The authors are indebted to Mr. A. Schneider and Mr. A. H. Huss for their assistance in these experiments.

*And has since published some results of experiments by the method.

†See above.

* THE ELECTRICAL WORLD, Oct. 1, 1892.

hours, 1.91 watts per candle = 73½% (2.60 watts at the commencement, against 4.51 watts after 500 burning hours).

DECREASE OF CANDLE POWER.

(a) Of the Berlin lamp (3.7 watts), in 1,000 burning hours, 12.15 candles = 75% (16 candles at the commencement, against 3.85 candles after 1,000 burning hours).

(b) Of our own lamps (2.6 watts), in 1,000 burning hours, 9.60 candles = 60% (16 candles at the commencement, against 6.40 candles after 1,000 burning hours).

INCREASE OF CONSUMED ENERGY.

(a) Of the Berlin lamp (3.7 watts), in 1,000 burning hours, 9.70 watts per candle = 263% (3.70 watts at the commencement, against 13.40 watts after 1,000 burning hours).

(b) Of our own lamps (2.6 watts), in 1,000 burning hours), 3.14 watts per candle = 121% (2.60 watts at the commencement, against 5.74 after 1,000 burning hours).

We should not have published the preceding comparative tests, which we only made for our own information, if we had not been compelled to do so by the Berlin circular mentioned before. Such tests, to be of practical importance, ought to be made with at least 100 lamps of each sort. In the temporary factory, where we are still compelled to work, we are lacking the necessary arrangements, but we hope to open our new factory at once, and will then make and publish comparative tests on a large scale. We may, however, at once express our conviction that in these extensive comparative tests the relative decrease of candle power and increase of consumed energy will be even more strongly in favor of lamps below 3 watts, than in the results of the tests just mentioned.

In the meanwnile it is an incontestable fact that the relative decrease of candle power and increase of consumed energy of our own lamps of 2½ watts and less during their average life is by no means more unfavorable than those of the best glow lamps of foreign make, taking 3—3½ watts per candle.

The considerable saving which may be effected by using our lamps consuming less energy than those hitherto in common use is an absolute fact, which can easily be ascertained by any consumer.

We confidently recommend our 2½ watt lamp up to 120 volts E. M. F. for any application whatsoever.

Our 2-watt lamp can only be recommended at low voltages (65 volts at the outside for 16 candles). In lamps of higher candle power, higher voltages are admissible.

Our 1½-watt lamps may be recommended for 100 candles and more at any voltage. For 16 candles and less, the E. M. F. ought not to exceed 40 volts at the most, and the lamps must be exclusively fed from accumulators.

Mr. C. J. Robertson, of the Elektrische Gluhlampen Fabrik "Watt," in a recent communication to "The Electrician" (London) gives the following information in regard to continental incandescent lamps which may be of interest in connection with the above circular, and that of Siemens & Halske, which was printed in "The Electrical World" of Oct. 1:

"A short time ago I called attention to the recent English and American lamp tests as showing results far inferior to the older Vienna tests of continental lamps. Knowing from day to day what progress has been made in lamp manufacture on the continent since the latter tests were made, I was in a position to claim superiority for the continental lamps over the English and American ones; but I was not in a position to quote any independent figures. Since then, by the courtesy of Messrs. Ganz & Co., of Budapest, I have had the opportunity of examining and (through Mr. Deri) of publishing the following extract from a report of the International Electric Company of Vienna to Messrs. Ganz & Co., of Budapest:

"'August 27th, 1892.

"'The 15 glow lamps which the factory "Watt" let us have for trial purposes were tested and gave the following values:

Hours.	Average energy in watts.	Average c. p. in normal candles.	Life in hours.
0	49 75	16	1 lamp 55 hours.
50	49.70	16	1 " 912 "
260	49.70	16	1 " 1,080 "
670	49.60	15	1 " 1,368 "
1,150	49.40	14	1 " 1,660 "
1,730	49.00	12.5	1 " 1,680 "
			1 " 1,850 "
			The remaining eight lamps still burning.

"'(Signed) M. DÉRI, Director.'

"For the sake of comparison I give a table below, wherein I have worked out the average watts per candle, and the mean percentage of original candle power, in order to compare them with the recent Ohio tests of the best American lamps:

Hours.	Averarge watts per candle.		Mean percentage of original.	
	Watt lamps.	G American lamps.	Watt lamps.	G American lamps.
0	3.11	4.20	100 per cent.	100 per cent.
50	3.10	4.40	100 " "	97.5 " "
260	3.10	4.95	100 " "	88 " "
670	3.30	5.90	94 " "	71 " "
1,150	3.53	6.75	87.5 " "	61 " "
1,730	3.93	—	78 " "	—

"In the above table the lamps of 3.11 watts per candle should have changed their efficiency and candle power at a far more rapid rate than those taking 4.2 watts per candle, if they had been equally well made. If the above lamps were considered to be 'all out' when they had only dropped 22% from their original candle power, then their average life would have been 1,280 hours for an average of 49.5 watts and for an average of 14.75 candles, whereas the American lamps would have been 'all out' at 260 hours and taking an average of 72.6 watts and giving an average of 16.1 candles. On the basis of an average of 16 candles at the same watts per candle, this would, with the 'Watt' lamps, be equal to an average life of 1,280 hours for an average of 53.7 watts.

"The above results will answer the following points which several of the chief electrical papers have considered desirable of attainment on the part of lamp manufacturers: (1) the production of a lamp which for a life of 1,000 hours should give an average of 16 candles for 56 watts; (2) the production of a lamp which shall not vary much in illuminating power during its useful life, this object being even worth attaining at the expense of a slightly lower efficiency."

Electro-Metallurgy.—XVII.

BY F. M. F. CAZIN.

A third and a fourth competitor then come in for electrolytic copper production in the shape of the claims patented to Dr. Karl Hoepfner, of Giessen, March 2, 1888, and to Hermann A. Seegall, of Berlin, both covering schemes for using chlorine compounds as a medium of solution and extraction.

Hoepfner dissolves cuprous chloride (CuCl) in a solution of common salt (NaCl). At the anode the CuCl is changed into $CuCl_2$, forming the aniolyte. Such aniolyte ($CuCl_2$) is employed outside of the electrolytic bath as a solvent on copper sulphides (CuS or CuS_2) and takes up enough copper to form Cu_2Cl_2 in a reaction represented by

$$CuCl_2 + CuS = 2\,(CuCl) + S$$

The solution will contain 2 (CuCl) (S being left with the ore and undissolved), serves as a cathiolyte and loses 1 Cu as cathion and changes the remaining CuCl at the anode again into the solvent $CuCl_2$. It is thus shown, that of 2 (CuCl) only a portion can be disengaged, as otherwise the process would stop.

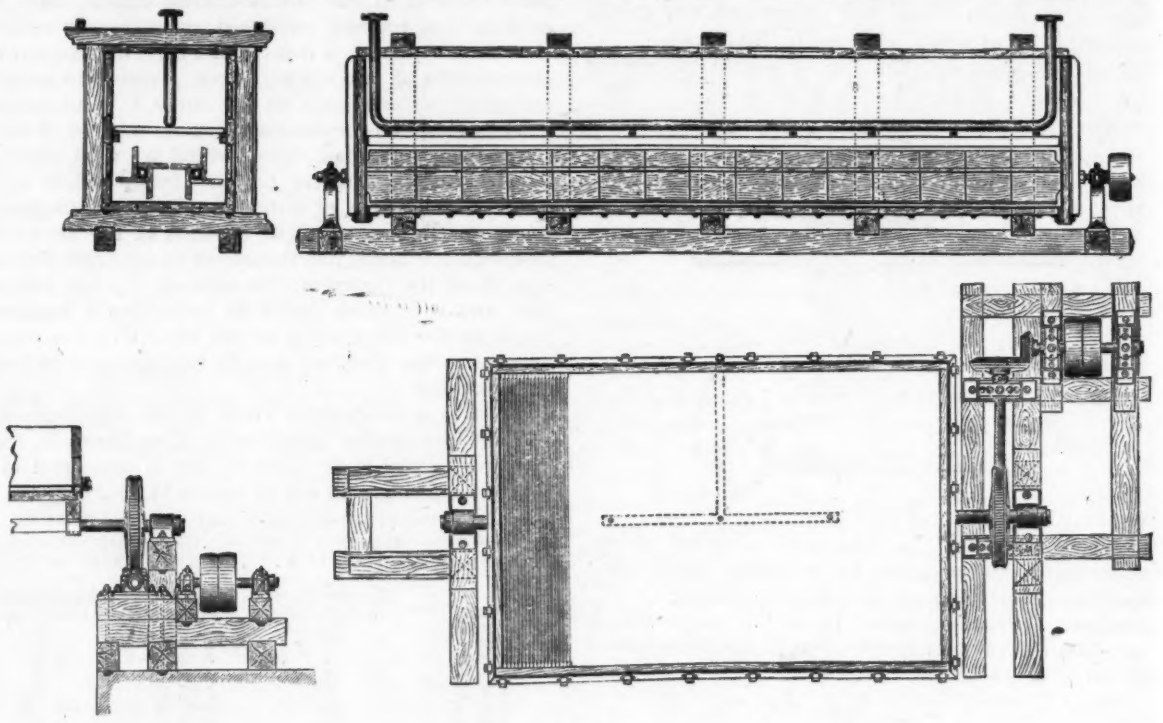
The patentee recommends the circulation of the cathiolyte through more than one cathode space, evidently otherwise fearing a result being shown different from what he states as quantity disengaged per ampère, as well he may.

The presence of an excess of iron chlorides in the solution interferes with the process, and the electrolyte must from time to time be regenerated by precipitating the iron through the addition of copper oxide. The necessity of purchasing common salt and of manufacturing cupric oxide (CuO) constitute practical impediments against the acceptance of the Hoepfner process not easily to be overcome on this continent. The inventor claims a production of copper per ampère in excess of that from sulphates, but the chemical scheme as specified by him does not justify the claim, because of 2 CuCl (or 1 Cu_2Cl_2) only the copper of 1 CuCl is disengaged at a time, 1 $CuCl_2$ going of necessity over to the next operation. In a lecture which he held before an association of chemists in 1891 Prof. H. stated among other things, that the cathiolyte in passing a series of cathode spaces did lose "almost all its copper," and yet is the presence of CuCl in the aniolyte an absolute condition to solving the copper from the ore. This and other "contradictiones in se" create the suspicion of loose observation, notwithstanding the process is in actual practice at three different places in Germany. Nor does it appear that Prof. H. comparatively gains in energy consumed, because the chemical energy consumed in the solution of Cu from the ores must be compensated for in the electrolytic action which is no other than the decomposition of the CuCl and the simultaneous formation of $CuCl_2$ energy, which would be without change of volume and without resistance of electrolyte compensating, if the caloric effects of forming CuCl from Cu and of forming $CuCl_2$ from CuCl were identical, which they are not, the same as the effects of forming CO from C and CO_2 from CO are not identical.

The process suffers also from the silver preceding the copper as cathion and a separation of the two not being effected in the operation. It is therefore necessary not only to clear the cathiolyte before it is subject to electrolysis, but to subject it to such chemical reaction as will save the silver, etc.

The Seegall process (March 2, 1888) is distinct from the Hoepfner process in this only, that as a solvent of copper from its ores Seegall uses ferrichloride (Fe_2Cl_6) in place of $CuCl_2$. The copper is obtained as cuprochloride, which is indissoluble in the extracting liquid, but which after subsidence therefrom is dissolved in brine. All the difficulties and inconvenience met with in the Hoepfner process must of necessity be met in the Seegall process, to which is added the practical impossibility to fully extract the copper from its ores by the instrumentality of a solution that does not also dissolve the copper compound that it produces. All reliance for the extraction of the copper compound is on the mechanical action of the liquid, but the compound in its new shape is as apt to adhere to the bulk of the other ore constituents as it was in its original shape.

A few words should also be said about the manner in which the different inventors handle the ores for the purpose of extracting the copper therefrom. Two specific and different manners are applied. Hoepfner uses revolving barrels, subjecting the ore to the motion resulting from the revolving of these barrels for a considerable time in alternate lots. What this method possesses in thoroughness of action is neutralized by the loss of automatic continuity of the entire manipulation.



FIGS. 1 AND 2.

Siemens & Halske recommend, employ and sell the apparatus, though not of their own make, as shown in Fig. 1. It is essentially a stirring vat 4.5 m. long and 0.75 m. wide with two four-winged revolving stirrers placed in the longitudinal lines of the vat. Both the vat and the steel shafts of the stirrers are lined with sheet lead. The pipe shown in the illustration above the stirrers is a lead pipe and is intended to serve as a steam heater for raising the temperature of the liquid in order to facilitate the reaction of the aniolyte on the ore. This apparatus is supplemented by a filtering apparatus (Fig. 2) for separating the liquid from the solid or residues. It also is lead lined. The solid residues remain on the false filtering bottom, which consists of a grate of wooden bars, a perforated sheet of lead resting thereon and a felt cover. The lower space is to be connected with the suction end of an air pump of suitable material for the collecting of the regenerated cathiolyte. The machinery shown in the illustration is of a clumsy, badly calculated construction, and the form of vat is inappropriate, the entire arrangement showing none of the good qualities usually characteristic of all that this firm makes, sells or recommends. The horizontal section of the vat, to answer its purpose more adequately, should be less than its depth. The whole apparatus should be pivoted for the purpose of emptying it at its meta-centre, thus avoiding mechanical labor and excessive strain on parts. And with the wormshaft prolonged from apparatus to apparatus, the same or one single gearing would answer for a series of filtering apparatus in line, if the cockwheel be made movable on the filter pivot shaft. The main fault, however, must be found in the division of action between two apparatuses, that might as well be performed by one, and which indeed more effectively is done in one in the same time than it possibly could be done in two.

The semi-circular vat heretofore illustrated, provided with the false bottom and above it with propelling stirrer, the shaft of which serves the double purpose of moving the stirrer, and when locked to the vat for turning it over on its meta-point, and a connection for the pump at the middle of the semi-circular bottom, would make a simpler, more adequate and less costly arrangement for both regeneration and separation of liquid.

But with these mechanical advantages this apparatus would combine the very important quality of continuous and not alternately interrupted action. With continuous inflow of both liquid and solid the propelling stirrer jointly with a continuously well regulated pump action will produce an automatic continuity of action, without which no establishment for treating ores can be considered as well equipped in these days of mechanical and metallurgical progress.

In relation to the process, in the carrying out of which the described apparatus is to be used, it is but proper to further state that on May 16, 1883, Michael Body, of Liège, Belgium, took out a patent for the use of ferric salts for copper extraction and for the electrolytic regeneration of the ferric salts into ferro salts. But his description is of so loose and general a character that the patent will not likely protect him against his ideas being utilized by others of a more practical turn of mind. And yet his patent offers good material for contesting the novelty of many claims since patented in the United States.

In view of what has been known in chemistry at large for many years, it would appear as objectionable to patent any of the known chemical processes on account of it being used in connection with electrolysis, and in case of contest there is but little expectation that a patent issued on such a process would hold good. And even with regard to apparatus patents a close examination of technical literature will reveal in many cases the fact that what is claimed as new is old indeed, of which fact the Andre patent of 1887 and his horizontal and even inclined electrodes give a good illustration.

When describing the apparatus, as employed by S. & H., in carrying out their peculiar process, I had to point out the fact that faulty position of electrodes had induced these manufacturers to attempt repairing the evil thus done by further complicating the general construction and introducing revolving cathodes, or a feature which Elmore had proposed for combining electrolysis with the manufacture of copper tubes, but so far without any apparent success, except the promotion of companies with large capitalization for purchasing the patent right.

But yet the necessity remains of considering the more simple, less complicated, and, therefore, more acceptable form of cathodes, applicable under the older Siemens and Marchese construction of apparatus.

Cathodes.—In the practice of electroplating it has long been proven that to the electrolytic precipitation of any metal it is not conditional absolutely that both substance and surface of the cathode, or even either substance or surface of the cathode, be of the same metal as the intended cathion. But it is conditional to effective electrolytic precipitation that there be no purely chemical reaction between the metal salt dissolved in the cathiolyte on the one hand and the cathode on the other. Otherwise, the purely chemical reaction takes precedence, and is not materially interfered with by the action of the electric current, though it be applied.

To employ an iron or steel cathode, or one of tin, zinc or lead in a solution of $CuSO_4$ would result in the precipitation of Cu, but only as the result of chemical reaction, and only at the expense of the substance of the cathode plate, which would furnish an equivalent quantity of the cathode metal to the solution as a substitute for the precipitated copper, while in true electrolytic action the cathode loses none of its substance. And the precipitate obtained by purely chemical action is, in its physical qualities, different from a true cathion, the former being, as a rule, without cohesion and without crystalline structure.

Nevertheless, iron, tin, zinc and lead may be made to serve as cathode in the precipitation of copper by electrolysis, on condition that the copper in the cathiolyte be held in an alkaline solution not chemically affecting the cathode.

Of this fact advantage is taken in electrolytic copper refining apparatus for the purpose of lessening the cost of the permanent plant by substituting cathodes of a cheaper metal for those of copper, and for the other purpose of more facile stripping of cathode from cathion.

And the method followed for achieving these purposes consists in first electrolytically facing the sheets of less expensive metal with copper in an alkaline cathiolyte, and in subsequently using the copper faced plates as cathodes in refining with the use of sour solutions, such as belong to common practice, when copper plates are employed as cathodes.

The prepared cathodes of less costly but more easily flexible metal also offer the advantage that in bending their edge to form a cap, by which they may be hung over the bars serving as electric conductors, no special provision is required for either their support or their electric connection, and a resulting inclined position slightly at variance from the vertical offers advantages in promoting the movement of the cathiolyte over the face of the cathode. It therefore pays well in an electrolytic copper refinery to have an alkaline bath in readiness and reserve for preparing and repairing cathode plates of any of the cheaper metals.

A bath of the following composition the author can certify has done good and effective service:

Take (in weight) parts:

1 acetate of copper, $H_4 (CO)_2 CuO$.

1 carbonate of soda, CO_3Na_2.

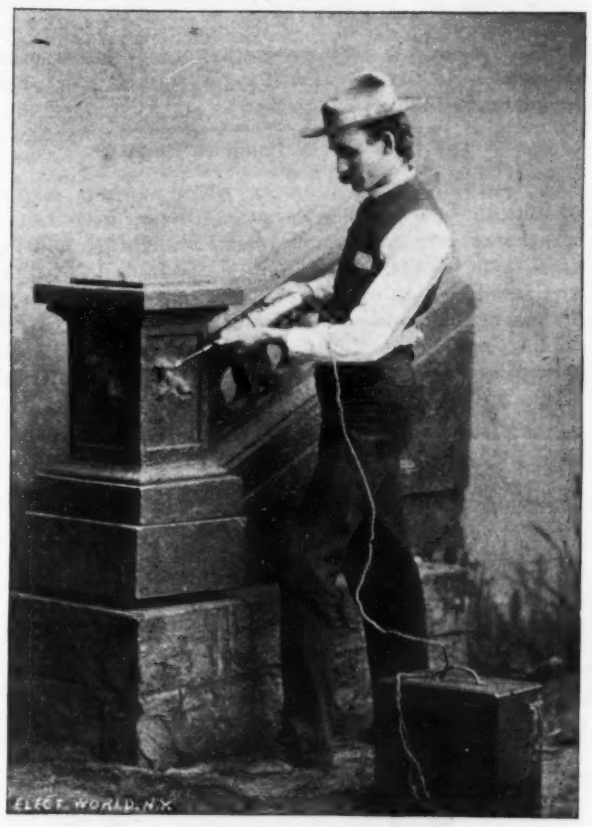
1 bisulphate of soda, SO_3Na_2.

1 cyanide of potassium, KCy and 50 water.

To prepare the alkaline electrolyte therewith the acetate of copper must be first dissolved in the 50 water and the 1 of carbonate of soda is then added in small portions so that the CO_2 which is liberated has time to escape without throwing part of the liquid out of the vessel. The liquid becomes thereby green and turbid, but when subsequently SO_3Na_2, and KCy are added, the solution becomes clear and transparent again, unless the chemicals used were impure, in which case the turbidity must be allowed to subside and the clear liquid must be decanted from the subsidence before it is used as electrolyte. It will then do effective and good work in the bath until its color begins to take a bluish tint, which is the evidence of its poverty in copper. It then must without interruption of action be regenerated by adding a regenerating solution, that is composed as follows in parts by weight:

2 CuCy.
2 KCy.
10 of water.

The author has found the solutions thus prepared and regenerated to do excellent work in coppering the named metals, when 0.4 ampères were applied per 0.1 m., and a pressure of three to five volts was applied, the latter allowing a distance of 0.15 m. between electrodes. It is self-evident that all metal sheets to be treated in this alkaline copper electrolyte must have their faces prepared by thorough cleansing. A preliminary immersion first in a solution of caustic soda and subsequently in one of cyanide of potash is an appropriate preliminary treatment. Cathode plates of other less costly metals faced with copper before being set to use should have all their parts not intended to be



Carstarphen Electric Reciprocating Tool.

covered by cathion and intended to remain above the bath as well as the edges faced with asphalt varnish, but without interfering with the electric connection, the facing being made thickest on the line where the plate meets the surface of the electrolyte.

It is self-evident that with these cheaper cathodes risks must be run, which do not exist when cathodes are used of copper sheet. Preferable to all others are the sheets produced electrolytically. If uneven solution of anodes has given occasion for technical precaution, the irregular deposit of cathion has not in a less degree been productive of hindrance and limited success. In a less degree this is experienced when electric density is so regulated as to produce a cohesive cathion (plates). When a crystalline product is the object worked for, it becomes a necessity in maintaining regularity of operation to mechanically clean the cathode faces by moving over them, even though they be not immediately rubbed thereby, a bar or brush in slow motion.

(*Concluded.*)

The Carstarphen Electric Reciprocating Tool.

A device which is likely to prove of great practical value in the art of stone carving has been invented by Mr. William P. Carstarphen, Jr., of Denver, Colo. The tool in actual operation in the hands of the inventor is seen in the accompanying illustration.

It consists merely of two solenoids placed end to end but separated sufficiently to admit of an automatic switching device in the intermediate space. An iron core or plunger passes through these solenoids and is alternately acted upon by them. By its movement it acts upon the switch and turns the current first through one solenoid and then through the other. This produces an attraction upon the plunger rapidly alternating in direction and gives to the tool, which is attached to the end of the plunger, the desired motion. The whole mechanism is so exceedingly simple that it is practically impossible for it to get out of order, or in any way to fail to do its work. The whole is inclosed in a metallic case to protect it from all mechanical injuries. The solenoids are wound in sections and a button on the outside of the case moving in a slot is so arranged as to commutate these sections and vary the speed of reciprocation according to the will of the operator. The rapidity of the plunger's motion varies from 300 to 600 strokes per minute.

The source of power is the storage battery, three cells of which are encased in a neat box which enables them to be transported with convenience. About six volts and from eight to ten ampères are sufficient to operate the tool under all ordinary circumstances.

The practical value of such a device is evident. Instead of having to strike the tool itself, the operator now has only to guide its movement, and can not only do his work much more rapidly, but can give greater attention to the working out of the design. It is estimated by those who have seen the tool in actual operation that it easily does the work of four men. Its field is large, for it can be applied with equal success to the sculpture of marble or the finishing of granite or other building stone. It has been found to be particularly useful for the carving of letters and similar devices where it is necessary to follow accurately straight or curved lines. In ordinary work, the stone carver has first to carve out the letters in the rough and then finish them, but the action of this tool is so true and so fine that only the one application is required.

The manufacture and sale of this tool is controlled by the Electric Reciprocating Company, of Denver, Colo., of which Mr. William M. Clarke, Park Avenue Hotel, New York, is the Eastern agent.

The Annual Meeting of the American Electro-Therapeutic Association.

The second annual meeting of the American Electro-Therapeutic Association was held in the hall of the New York Academy of Medicine Tuesday, Wednesday and Thursday of last week. The meeting was largely attended by the leading electro-therapeutists of the country, and some of the papers read proved highly interesting. The programme was long and varied and embraced almost every phase of this branch of the science. The sessions of the meeting were held in one of the main lecture rooms. In an adjoining room the various electro-medical instrument manufacturers made their exhibits. These were very characteristic of the advance made in this line of goods, and was by far the best ever made exclusively in this direction.

The importance of this meeting from the practical standpoint was shown by the interest which practical electricians took in the affair. Mr. A. S. Kennelly, of the Edison laboratory, while not able to attend in person, contributed several papers. Prof. E. J. Houston attended the meeting in person and took an active part in many of the discussions. Mr. John J. Carty, vice-president of the New York Electrical Society, attended, contributed a paper and also took part in some of the discussions. After the adjournment of the first day's proceedings the members were invited to a social reunion at the Electric Club. Another feature was an invitation to inspect the Telephone Exchange, and, finally, Mr. Thomas Edison, with commendable spirit, extended a cordial invitation to all the members to make a thorough inspection of his laboratory, in East Orange, N. J.

The opening session was called to order at 10 o'clock and Dr. W. J. Morton, of New York, gave his presidential address.

The Committee on Standard Coils was unable to make an official report. Dr. Augustin H. Goelet, one of the committee, made an individual statement. He said that the difficulties which lie in the way of such a committee can hardly be appreciated. He spoke of the disinclination on the part of the makers to co-operate with the physicians on account of the expense. His idea was to have a standard coil, so that the good results obtained by one physician might be duplicated by another possessing the same form of apparatus. Two firms had thought favorably of co-operating with him in deciding on a coil. They had made experiments and had submitted a coil for consideration, but he had been unable to satisfactorily test these coils. Dr. Hutchinson described his own coil and recommended that the committee be continued for another year. Dr. Morton suggested that a man versed in the physics of the science or an electrical engineer be appointed one of the committee, and proposed that Mr. A. E. Kennelly, of the Edison laboratory, be asked to serve on this committee.

The report of the committee on meters was delayed on account of the absence of members.

A paper on the "Use and Abuse of Electricity in Medicine" was then read by Dr. A. D. Rockwell, of New York. His paper was a résumé of what had been done and undone in medico-electric science.

The next paper read was on "New Contributions of the Electrical Treatment of the Diagnosis of Gynecology," by Dr. G. Apostoli, of Paris. Dr. Apostoli was not present, but his paper was read for him by Dr. Wm. F. Hutchinson.

The distinguished author of this paper is perhaps the best known electro-therapeutist in the world, and as a consequence his paper was heard with a great deal of interest. It was, however, largely medical in its nature. The next papers were, from the practical standpoint, the most important presented during the convention. This was the discussion on "Electric Cataphoresis and Its Practical Application as a Therapeutic Measure." Electric cataphoresis or endosmose has attracted a great deal of attention lately, not only from the medical man, but from the physicist as well. In view of this the aim in the present discussion was to obtain papers and opinions from every side and upon every phase of it. Dr. Peterson, of New York, opened the discussion. He was followed by Mr. A. E. Kennelly and Prof. E. J. Houston with a paper on "The Physics of Cataphoresis." They were followed by Dr. Wm. J. Morton on "Its Uses in General Medicine." "Its Uses in General Surgery" was treated in a paper by Dr. Wm. H. Walling, of Philadelphia; "Its Uses in Gynecology" by Dr. Augustin H Goelet, of New York, and again by Dr. Peterson on "Its Uses in General Medicine."

At the afternoon session there was a discussion on "Electric Cataphoresis and Its Practical Application as a Therapeutic Measure."

At the evening session the first paper was by Dr. R. J. Nunn, of Savannah, Ga., on "Stabile Electrodes." "The Value of Voltaic Alternatives in Optic Nerve Atrophy," by Dr. C. E. Riggs, was read by title, and then the evening's regular work was taken up.

After discussing several subjects of a more or less purely medical nature, the members went to the rooms of the New York Electric Club, and spent several hours in pleasant social intercourse.

Dr. W. J. Herdman, of Ann Arbor, Mich., inaugurated the second day's proceedings by a paper on "The Need of Greater Simplicity and Uniformity in Electro-Therapeutic Apparatus."

Dr. Herdman spoke of the need of a greater simplicity in the apparatus to be used and advocated that a standard for the various pieces be adopted. Good results can only be hastened by the perfection of the instruments in question. There was a lack of uniformity as well as a lack of simplicity, and while this existed progress was impossible. The physician, to properly administer the current, must be possessed of a static induction machine, a current controller, a coulomb meter, a milleampère meter, and innumerable electrodes. Perhaps only the specialist would feel himself called upon to possess all of these instruments, and for the sake of the general practitioner greater simplicity should be adopted. Uniformity was the first requisite in this direction, and he recommended that a committee be appointed. Acting on his suggestion a committee was appointed on standards of static machines, controllers and electrodes, composed of Drs. Kellogg, Cleaves, Massey, Herdman, Peterson, Newman, Rockwell, Nunn and Dickson.

The afternoon was taken up principally with an extended discussion on purely medical subjects. In the evening a reception was tendered by the resident members, and the executive session of the year was held for the election of officers. The following were elected:

President, Dr. A. H. Goelet, New York; first vice-president, Dr. Wm. F. Hutchinson, Providence, R. I.; second vice president, Dr. W. J. Herdman, Ann Arbor, Mich.; secretary, Dr. Margaret A. Cleaves, New York; treasurer, Dr. R. J. Nunn, Savannah, Ga.

Executive committee, Dr. W. J. Morton, New York; Dr. G. Betton Massey, Philadelphia; Dr. Robt. Newmann, New York; Dr. Chas. R. Dickson, Toronto, Canada; Dr. J. H. Kellogg, Battle Creek, Mich.

After the executive session the invited guests listened to a lecture on the phonograph and micro-phonograph by Dr. J. Mount Bleyer. Dr. Bleyer gave a short history of the various processes by which the phonograph has reached its present condition. One of the uses therapeutically to which the phonograph has been put is in the treatment of deafness. The impinging of the sounds on the drum of the ear is in effect somewhat after the manner of a massage treatment and is said to have a very beneficial effect. After Dr. Bleyer had read his paper he exhibited the phonograph and its operation to his audience. With the aid of Lieutenant Betteni the instrument was made to reproduce sounds of the voice in every degree and manner. By means of a bell-shaped trumpet attachment the sound was greatly magnified and airs from late theatrical productions were easily heard in all parts of the room.

The last day's proceedings opened by the reading of a memorial to the late Dr. Gilman Kimball by Dr. Ephraim Cutter, New York.

The paper by Dr. Newmann on "The Treatment of Strictures by Electricity," which had been postponed on account of the sickness of the author, was read. It had been hoped Dr. Newmann would be able to appear, but as he was unable to his paper was read by Dr. Nunn.

The better part of the morning was taken up by these papers. When finally, however, they had been disposed of, the members of the society proceeded in a body to the Twenty-third street ferry to take the train to East Orange, N. J., where, on the invitation of Mr. Thomas A. Edison, they made a thorough inspection of his laboratory at that place. After a most instructing survey of the works had been made, they returned to the city to prepare for the evening and closing session of the series.

At the evening session the most important paper, from the standpoint of the electrician, was by Dr. J. H. Kellogg, of Battle Creek, Mich., on "The Physiological Effects of a Magneto-Electric Current of Regular Variations."

The Electrical Engineering and Supply Company's Volt and Ampere Meters.

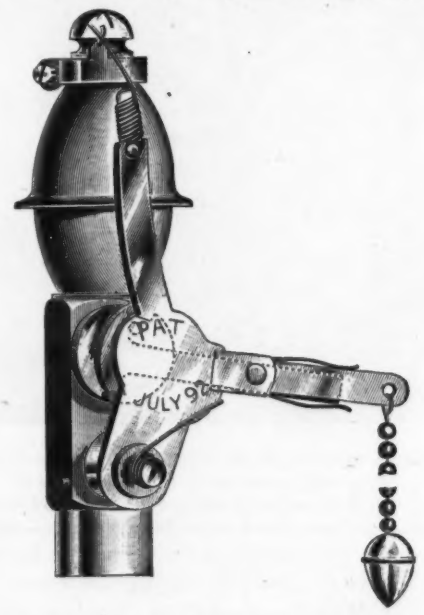
On account of the great demand for voltmeters and ammeters which are durable, accurate, economical and dead-beat, the Electric Engineering and Supply Company, of Syracuse, N. Y., has decided to manufacture and place these instruments upon the market. They are of the magnetic vane type, the principle being that of magnetic repulsion, which is controlled by a spring of great permanency by means of a large air vane of aluminium. The instrument is made quite deadbeat, and the pointer will come

The Electrical Engineering and Supply Company's Voltmeter.

to rest much quicker than in the ordinary instrument of this class. The pointer is furnished with a good-sized black dot to render the reading of the instrument possible at quite a distance. Very high resistance is aimed at in the voltmeters, and very low resistance in the ammeters, thereby reducing the consumption of power to a minimum. With a fine finish and an accuracy unexcelled by the commercial instruments, they are worthy of a position upon the finest switchboards, as well as for portable work, and are guaranteed to do good service.

The Iona Safety Pendent Burner.

The Iona safety pendent burner, which possesses several novel features, is shown in the accompanying cut. In this burner there is but one contact made in lighting and extinguishing the gas. This result is accomplished by the wire spring passing over the electrode on its return from the lighting pull, and on the off pull, by a very ingenious arrangement of the valve cam, the electrode not being touched at all. The on and off pulls are decidedly different,



The Iona Safety Pendent Burner.

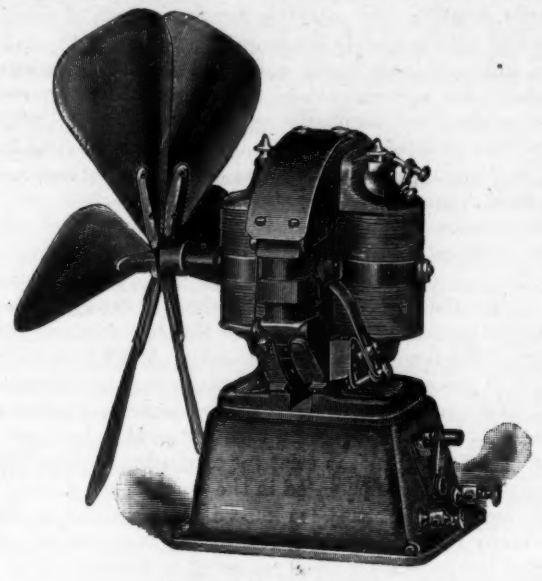
and one can readily tell even in the dark whether the gas valve is open or closed. There is no possible danger of mistake on this point. These burners are made in the best possible manner, the valves being hand ground and always perfectly tight. The movements are simple and positive, and there is no ratchet or complicated springs to get out of order. This burner is being placed on the market by the Redding Electric Company, 41 Federal street, Boston.

The Baehr Dynamo and Motor.

Mr. George Baehr, of Brooklyn, N. Y., is the inventor of a new dynamo and motor, shown in the accompanying illustrations, which possesses some features not found in any of the common forms.

The dynamo consists of two castings, each provided with pole pieces connected by a piece which forms the core for the two coils. The cores at the middle are enlarged to provide a bearing for the armature shaft. These castings are placed upon the base face to face, with a small space left between them. The winding is such that like poles are adjacent. The coils of these two castings may be connected in series with each other or in multiple, and the machine will be equally efficient, but if they are connected in multiple should one of the coils be burned out the circuit would still be continuous through the other magnet, and the lines of force produced by it would still act upon the armature independent of the destroyed magnet, and would pass through the armature in preference to the other field magnet because the air gap between the two castings is made a trifle greater than the air gap between the face of the pole and the armature core.

The armature is a Pacinotti ring supported upon the shaft by a cylindrical block of fibre or other insulating



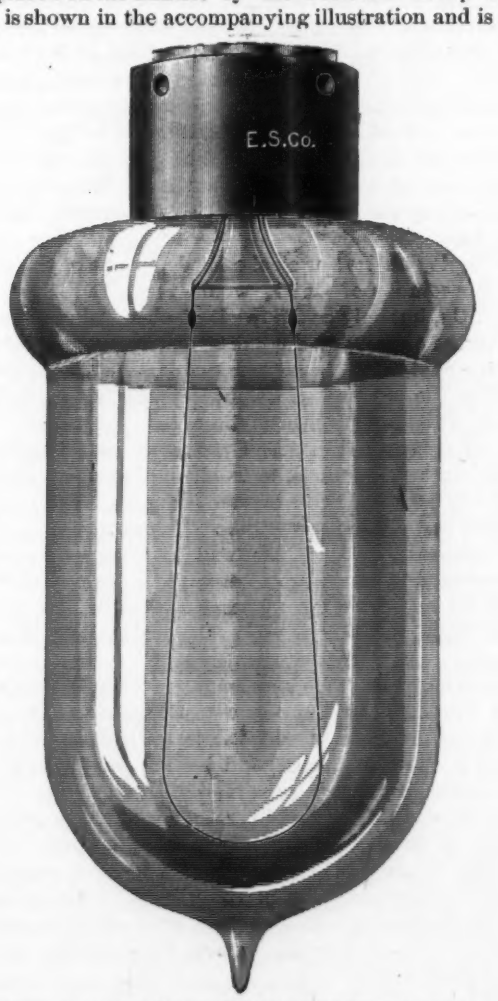
Baehr Fan Motor.

material, which serves as a spider, and to which the armature is secured by means of radial screws which pass through the lugs of the ring and into the block.

The commutator is formed of plugs having a threaded body, portions of which pass through the block of insulating material and project slightly on each side, one end of the plug being a broad flat edge against which the contact device bears and the other end having a slot to receive the screwdriver for working the plug into place. The ends of the coils are soldered or otherwise secured to the rear ends of the plugs. The contact device is a carbon pencil set at right angles to the face of the plugs in holders located on each side of one of the field cores and supported on brass arms. It will be seen from the construction of this commutator that the armature and commutator stand in the same plane, and that the commutator therefore adds nothing to the width of the machine.

The "Acorn Shape" Incandescent Lamp.

A new pattern of incandescent lamp, which has lately been placed on the market by the Sunbeam Lamp Company, is shown in the accompanying illustration and is designated as the "Acorn Shape." This lamp has been patented and is designed for decorative and other special purposes where something different from the ordinary shape is required. This seems to be the first radical change in the shape of the incandescent lamp since its introduction more than twelve years ago. The Electrical Supply Company, of Chicago, is the general agent for the Sunbeam incandescent lamp.



The "Acorn Shape" Incandescent Lamp.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

[Inquiries from our patrons for information relative to stocks and bonds of the various electric light and power companies are solicited, and will be answered in this column.]

NEW YORK, Oct. 8, 1892.

New York Financial Market.—The market has been decidedly of the bull order, based upon generally improved economic conditions. As well as a number of special events, a decided advance in the greater part of the list took place on Tuesday, and has been sustained. Some are inclined to the belief that it is the inauguration of the World's Fair boom, others that it is the reaction after a long period of depression. Money has fluctuated widely during the week, reaching 10 per cent. on call loans. Deposits on account of shipments of currency from July 3 to October 7, $6,575,000; Cincinnati, $1,880,000; Minneapolis, $720,000; other Western points, $4,273,000; Pittsburgh and other Eastern points, $1,218,000; New Orleans, $1,985,000; other Southern points, $1,242,000; total, $17,883,000. The amount deposited for the corresponding time last year was $37,047,000. The deposits were made later this year than last, and consequently are not as heavy as they were a year ago. This is considered due to the lateness of the crops and the presence of more money in the West. Bankers attribute the ease in money up to the present in some degree to the fact that there are 54 million dollars silver certificates additional in circulation in the country than at this time last year, and one or two banking officials say that in their opinion inflation has set in. They consider a general rise in the price of commodities due to the distrust of the present currency as not at all unlikely in the near future unless the Sherman act is repealed by the next Congress. Not all of the gold exports and the stiffness of foreign exchange is to be traced to foreign sales of our securities, part being due to the operation of the law that the poorer currency will drive the better out of circulation. This, however, is an extreme view and has application to the future, though some say the near future, rather than to the present.

ELECTRICAL STOCKS.

In General.—This department of the market has been the leading feature. The decision in the incandescent lamp case made on Tuesday, and reported in full exclusively in these columns, was the basis of a pronounced bull movement in General Electric and Edison Electric Illuminating. These will be taken up in separate heads and treated in detail. The course of the list next week will be conditioned in a measure upon the general market. If it remains strong as during the past week we are of the belief that General Electric will score further advances, especially in its bonds—a condition which will also be the case with Edison Electric Illuminating. Relative to the stocks receiving minor transactions the following points are of interest: American District Telegraph received the first sale in two weeks, it being at 59½. This figure was bid at the close and 61 asked. American Telegraph & Cable received one sale at 86. North America developed considerable strength caused by buying orders, of which there was more in the market than for some time past. The highest price reached was 13½; the closing was a fraction under this figure. There is no special news concerning this property, except that it is enjoying a good business. Commercial Cable was not traded in, although it was held at the highest figure yet recorded on the Exchange, viz., 169. As high as 164 was bid, against 161 last week; 157 was the lowest selling price of last week.

Western Union.—This stock scored a material advance. It was started by traders who found little or no stock for sale, and who were successful in starting other purchasers when it was bid up. The rise of the stock was accompanied by a rumor of the announcement by the directors that the proposed distribution of new stock would soon be published. We understand that there will be no announcement by the directors until after action has been taken by the stockholders at a special meeting to be held at the end of this month. The plan, however, is the same as published by THE ELECTRICAL WORLD some time ago. Stockholders will be given a bonus of 10 per cent. on the capital stock existing prior to the increase of the total capital, so that the stockholders will get a dividend which, at the present price of the stock, is equivalent to about 10 per cent. This makes the stock cheap as an investment, but the point speculatively is that the increase of capital will bring new stock on the market in considerable amounts. People otherwise bullish on Western Union wish to see this stock digested before undertaking any fresh speculative movements in it. Quite a large part of the new stock will be offered for sale and cannot be other than a temporary load upon the market. The highest point reached was 97 on Wednesday and the closing was strong at a fraction less. About $15,000 of its collateral trust 5's sold at 103⅜ to 103¾. The resolutions under which the company will increase its capital stock contain a preamble in which the following language is used: "It is for the interest of the company to still further extend its business by adding to the number of wires and conductors upon its existing lines, by constructing or acquiring other lines, plants and properties, to operate in connection with existing lines, plant and properties, made necessary by the growth of the company's business, etc." The impression gained by some people from reading this preamble is that the company has had in mind the acquisition possibly of the Postal Telegraph Company. One of the directors when asked if this was a correct impression said: "No; the preamble was worded simply to cover the language of the charter of the company in the matter of increasing its capital. The company has no thought or intention of acquiring the property of the Postal Telegraph Company. It is, however, steadily adding to its own lines by construction. The public would be surprised if it knew to what extent Western Union was increasing its facilities and improving its property. The amount of copper wire of the finest grade just purchased is almost a new departure in the history of the company because of the size. It is not proper that details should be given at this time. The company is also compelled to steadily purchase and build larger offices at different important centres, which costs a great deal of money."

General Electric.—The decision of the United States Court of Appeals giving the company the exclusive right to the patents on the incandescent lamp stirred Wall street with enthusiasm. The news first reached the Street through Dow, Jones Company. Unlike most contingencies reasonably certain to affect the value of stocks, it had not been discounted. The closing on Monday was 113¼. Upon receipt of the news a large number of transactions took place, running the price up to 117½. Trading has been heavy, by jerks and spurts, ever since. However, there has been very little realizing prior to to-day, and the quotation reached 119⅝, the highest price ever paid for the stock. To-day there was some realization and the price fell off to 118⅛. The total transactions of the week were 80,000 shares, representing a value of, say, $9,360,000. A fair portion of this stock has been put away. The debenture 5 per cent. bonds which are exchangeable for stock did not so readily respond. However, on Thursday and to-day transactions were very heavy. On Monday sales were made at 104¾. The closing was 106¼. A total of $429,000 were dealt in. There will probably be some realization next week. We do not believe that it will cause any marked decline. Some opinions on the effect of this decision are given elsewhere in our columns.

Westinghouse.—Whatever may be the ultimate effect of the decision on the Westinghouse company, the present stock quotations do not show that the public regards the present situation as critical or even ominous. There was no dumping of stock on the market, as is the case when holders have an undesirable security on their hands. On the contrary, there was the same lack of transactions as has characterized the stock on the Exchange over a period of six months. But four sales were made. In these the E. & M. assenting certificates dropped from 77½ to 75¾. The preferred sold on Monday at 101 and was not a second time traded in.

Minneapolis and St. Paul Street Railways.—Kountze Brothers and Clark Dodge & Co., of New York, and Lee, Higginson & Co., of Boston, offer for sale $1,000,000 five per cent. cable consolidated gold bonds of the St. Paul City Railway Company at 95 per cent. and accrued interest. The Twin City Rapid Transit Company, of which the St. Paul City Railway Company is a part, operates 210 miles in all: 195 by electricity and 15 by cable. A double track electric road, nine miles in length, connects the business centres of Minneapolis and St. Paul. The cities have a combined population of 350,000. The bonded debt upon the St. Paul City Railway Company is $5,157,000, and upon the Minneapolis Street Railway Company $4,970,000; a total of $10,127,000. Gross earnings for 1889 were $976,086; 1890, $1,337,190; 1891, $1,820,592. The company earned in the first seven months of 1892, gross, $1,191,857, and net, $400,401; after payments of interest on debt, etc., there remained $91,371. Betterments and extensions have all been completed. The company owns its plant for the manufacture and repairing of electric motors.

Dividends.—General Electric Company has declared a 2 per cent. quarterly dividend, payable Nov. 1. Books closed from Oct. 15 to Nov. 1, inclusive. The Edison Electrical Illuminating Company of New York has declared a quarterly dividend of 1¼ per per cent., payable Nov. 1. Transfer books close Oct. 15. The Northwest General Electric Company has declared a 2 per cent. dividend on common stock, payable Oct. 15 to stock of record Oct. 7. Books close Oct. 7 to Oct. 15, both days inclusive.

Edison Electric Illuminating of New York.—This stock experienced even a greater advance than General Electric. It is held in very high favor by investors, and there is no doubt that a portion of the advance was sentiment. Nevertheless, it comes in for a share of General Electric's good fortune in the incandescent decision, owning, as it does, New York rights. Transactions were more numerous than in months, carrying the price from 101 up to 107⅝. It weakened a little on realizations at each advance, and on Friday, the date of its highest price, it also sold at 105. There was considerable call for its bonds, $50,000 selling at 105½ to 107½, the latter being the closing. The company has declared a quarterly dividend of 1¼, payable Nov. 1. Transfer books close Oct. 15.

Closing Quotations.—The following were the closing quotations of electric stocks on Saturday, Oct. 8, 1892, and the range for the week in New York:

NEW YORK QUOTATIONS.

	Par.	Capital outstanding	Lowest	Highest	Bid.	Ask'd.
American District Tel....	100	3,825,000	59½	59½	59½	61
American Tel. & Cable..	100	14,000,000	....	....	86	87
Central & So. Am. Tel....	100	6,000,000	....	....		
Commercial Cables.....	100	7,716,000	....	....	164	169
Gold Stock & Tel.....	100	5,000,000	.	....	100	103
Bonds.....	500	500,000	....	....	100	..
Postal Tel. & Cable.....	..	10,000,000	....	....	62	64
Southern & Atlantic Tel..	25	948,775	....	....	78	84
Western Union Tel.....	100	86,199 852	95⅛	97	96½	97
Real estate bonds.....	1,000	1,219.000	....	....	....	
Debenture bonds.....	1,000	4,920,000	.		..	....
Collateral Trust 5's....	1,000	8,181,000	103⅜	103¾	....	....
North American.....	100	39.767,200	12⅛	13⅛	12⅛	12⅞
Brush Ill. Co. of N. Y.....	50	1,000,000	....	....	30	60
Edison El. Il. of N. Y.....	100	6,500,000	101	107⅝	105	107½
" " 1sts.....	...	.....	105½	107½	...	
" " Deb's.....	...	.....	102½	102½	...	....
Edison El. Il. of Brooklyn.	100	750,000	...	....	85	90
" " " " Chicago..	100	750,000	....	....	130	145
" " " " Boston...	...	.....	....	....	115	125
Edison El. Lt. Europe....	1,000	2,000,000	....	....	2	6
" Bonds.....	...	30,000	....	....	65	80
Edison Ore Milling Co....	...	2,000,000	....	....	15	20
East River El Light.....	100	1,000,000	...	....		65
General Electric.....	1,000	50,000,000	112½	119⅝	119⅜	119⅞
Debenture 5's	....	.....	104¾	106¼	....	....
Automatic Exhibition Co. ...		2,500,000	. ..	....	3	5
Mt. Morris Electric.....	...	500,000	....	....	....	65
N. E. Phonograph.....	..	2,000,000	....	....	2	4
N. Y. Phonograph.....	...	2,000,000	....	....	2	5
North American Phonograph.....	...	2,000,000	....	....	4	6
Westinghouse Elec. & Mfg. Co. 1st p. 7 per cent. Cum.	50	3,717,253	101	101	101	102½
E. & M. Co. Assg.....	50	5.038,116	75¾	77½	77	79

WALL STREET NOTES.

Erie Telegraph and Telephone Company.—The capital of this company's sub-companies in Minneapolis, St. Paul and Cleveland is to be increased for establishing in their territories a system of long distance telephone lines. The Erie company will take its proportion of new stock and liquidate its present indebtedness of $200,000, incurred on underground work and extensions already completed. It will probably require at least two years to complete the work contemplated.

The Fire Underwriters and the Edison Illuminating Company.—The Edison Electric Illuminating Company and the New York Board of Fire Underwriters are clashing over the question of grounded wires. The grounded neutral is a fundamental feature of the Edison system of lighting in New York City and the company alleges that it is in no way inimical to the safety of the community as regards fire. The underwriters, however, acting in pursuance of resolutions adopted last March, are trying to bar all grounded wire systems from having any part in the lighting of the city, alleging that they increase the danger of fire. The time allowed by the board in which companies should remove all grounds expired Oct. 1. Since that time the board has refused to inspect electric equipment, anticipating the use of the Edison system, and will not issue certificates of condition. This action is likely to lead to complications with the insurance companies, which will not accept risks held unsafe by the board. Secretary Pryor, of the Edison company, said that they looked upon the action of the board as unwarrantable. Grounding, he explained, was a matter of street and station service, and not at all connected with the installation or the wiring, which was all that the board should take cognizance of. He said also that, should the matter come into the courts, it would rest upon the board to prove that the grounded wire was really a menace; at present it contented itself with saying that it seemed to be one. Assistant Superintendent Harrison, of the survey department of the Board of Underwriters, said: "The company will have to come to our terms. All there is about it is that by the grounding it effects an economy. It can furnish light for less than any other company in the city. But there is an increased risk. We propose to do away with that risk. The insurance companies will uphold us in our action." A conference has been held between President Johnson and Director D. O. Mills for the company, and William A. Anderson and Prof. Morton for the board, looking to an agreement. It is hoped that it may produce some satisfactory basis of settlement. In the meantime we understand that the underwriters do not propose to inconvenience policy holders, at least not so long as there is any possibility of a settlement.

Copper Market.—There has been a material improvement in the copper market. It is based upon a firmer London tone. Consumers short of supplies rushed into the market, carrying up the quotations from 11¼ to 11¾. The Lake companies immediately seeing the advantage of their position, retired from the market holding their supplies at 11¼ cents. We understand that sales were made of 100,000 lbs. at that figure. Arizona and Montana matte producers have held conferences during the week with the object of agreeing on some basis of price; but, so far as can be learned, came to no conclusion. The exports this week from the port of New York consisted of 441,402 lbs. of matte and 273,155 lbs. of fine copper.

BOSTON, Oct. 8, 1892.

The General Market.—The market has in a measure broadened during the week, and there is some interest shown in it by the public now, although for some time past it is largely a traders' market, and therefore speculative, liable to change, and without real good character. There has been a decided strengthening in the more prominent railroad stocks. The favorable statement of the Atchison road gave the stock a slight impetus, but it is worthy of a much higher figure than it sells at present, and must surely reach it. New England has led the market and scored a good advance, on pronounced but very indefinite news of some deal not yet made public. The copper stocks have had a good share of the interest, and prices show a good advance. Boston & Montana has been the most active and is demonstrating what its friends have been claiming for the property. Osceola has gained five points on very few sales, showing good strength behind it. After a very prolonged period of dullness, during which it has hardly been heard of, Centennial has again been taken up, and shows a slight increase in price. Advices from the mine report valuable discoveries, which promise large returns. Money is easier at the close of this week than for a month past. Call loans have finally come down to 4¼ per cent. and this rate is expected very soon on all loans. The conditions incline toward a still easier market, and more plentiful supply. The October disbursements apparently had rather a different effect than was anticipated and naturally looked for, in being followed by this easy market.

Electric Stocks.—Among the industrials, General Electric has once more returned to the front rank, and since Tuesday it has been a most attractive card. The recent incandescent lamp decision was not previously discounted on this stock, for as soon as it was made public the price immediately reflected it, and at the rate of three and four points a day it rose to 119⅞, the highest reached, on Friday. Its friends name 150 for the stock, but that is not probable on this market while trading is so restricted, and raids so imminent. A reaction is more than probable after the present boom, and then one may look for a good figure in the stock on a steady and broad winter market. The preferred stock is held so closely that sales are very few; last ones being at 118½. Westinghouse is apparently as strong as ever in the face of the court decision that would seem to affect that company the most. Its supporters say that the company has something in reserve that will give to it all that the recent decision deprives it of and even more. From 38¾ it fell off to 36½, recovering later a part of its loss. Very little stock came out, and its backers are evidently holding on tight and willing to support it as in the past. Telephone stocks have been more active than usual, and the quotations show better figures. New England at 62 is the highest that it has reached in many months. Erie is strong and moderately active at 46½ to 47½. Bell reached 203 again, with the dividend off only a week. A few points either side of this figure are, at best, only temporary, and here it remains. West End closes at 72½, which is a point better than for some weeks past.

The East Middlesex (Mass.) Street Railway Company has increased its capital stock by 50 per cent., to $300,000, and offers to shareholders of Sept. 23 the privilege of one new share at par for each two shares now held. This right is open till Oct. 24, when the new stock will be issued and a payment made of 25 per cent., and the balance after Jan. 1. The stock recently sold at 106, and therefore there is a right, worth about $2 each, attaching to each old share. This road operates between Chelsea, Malden, Woburn, Melrose and Revere, Mass., and has been constantly increasing in value since its inception, about four years ago. The new stock is issued to provide for electrical equipment, which will replace horses at an early date.

BOSTON QUOTATIONS.

	Par.	Capitalization.	Highest.	Lowest.	Bid.	Ask'd.
Thomson-Houston Elec.—Series C	sh	40,000	9	....	8¾	9
Thomson-Houston Elec.—Series D	sh	120,000	8½	8	8¼	8⅛
Thomson Elec. Weld.. ...	100	1,000,000	....	....	....	....
Thomson European Elec. Weld.....	100	1,500,000	10	....	....	10
Westinghouse Elec.—New Com.	..	6,000,000	38¾	36½	37⅛	37¾
Westinghouse Elec.—Pfd.	..	4,000,000	51	47½	49¼	50
General Electric.....	..	30,067,200	119⅞	112¼	119	119¼
" " Pfd ...		4,136,300	119	118	118	118¼
Fort Wayne Elec.....	25	4,000,000	13	12½	12¼	12¾
Fort Wayne Elec.—Ser. A.	sh	80,000	8	....	8	8¼
Detroit Elec.....	10	750,000	5¼	5	5	5¼
West End St. Ry. Co.—Com	50	7,150,000	72½	71⅞	72¼	72⅜
West End St. Ry. Co.—Pfd	50	6,400,000	87¾	87	87¼	87¼
American Bell Tel	100	15,000,000*	203	198	202	203
Erie Tel. & Tel. Co.....	..	4,800,000	47¼	46	46⅞	47
Mexican Tel Co.....	10	1,280,000	....	....	1	1.10
New Eng. Tel. & Tel. Co..	..	10,304,600	62	60	62	....
Tropical Tel. Co.....	10	400,000	10c	....	....	20c

* Ex dividend.

CHICAGO QUOTATIONS.

Following are the quotations of telephone and electric stock furnished THE ELECTRICAL WORLD by C. V. Banta, Jr., 167 Dearborn street:

Telephone Stocks:	Bid.	Ask'd.
Chicago.....	214	....
Central Union.....	58	59½

Electrical Stocks:	Bid.	Ask'd.
Chicago Arc Light & Power Co.....	100	103
Chicago Edison Co ...	150	..

NEW INCORPORATIONS.

The Citizens' Light and Power Company has been incorporated with a capital of $150,000 to furnish electricity for public and private purposes in Rochester.

The General Incandescent Arc Light Company has been incorporated with a capital of $250,000 for carrying on a general manufacturing business in electrical appliances in New York City.

The Nevada Electric Company, of Nevada, Ia., has been formed with a capital stock of $18,000, to build, equip and operate an electric power plant. T. L. Seevers, F. P. Kennedy and M. M. Seevers, of Nevada, are the promoters.

The Standard Electric Company, of Clinton, Wis., capital stock $20,000, has been formed to manufacture and sell electric

lamps, dynamos, etc., and to furnish electric light. L. Lusk, A. Woodward and E. Opperman are the promoters.

The Marion Electric Light and Street Railway Company, of Marion, Ill., capital stock $20,000, has been formed to furnish electric light and to build and operate a street railway in that town. J. G. Mitchell, Wm. H. Warder and W. H. Bundy are the organizers.

The Peopies' Street Railway Company of Nanticoke and Newport, of Nanticoke, Pa., capital stock $60,000, has been formed to construct and operate an electric railway in Nanticoke and other towns. Wm. Fairchild, B. A. Bache and Henry Schappert, of Nanticoke, are the promoters.

The Barberton Electric Company, of Barberton, O., capital stock $40,000, has been formed to manufacture and distribute electricity for illuminating purposes and for power and heat. F. H. Bostwick, B. F. Tracy, Edward A. Huene, Edward G. Waters and H. A Robinson are the promoters.

The Empire Electric Company, of New York, capital stock $25,000, has been formed to manufacture and sell electrical appliances. W. K. Freeman, 150 Nassau street; Henry Seldner, 150 Nassau street, New York City, and D. S. Woodworth, 181 Tremont street, Boston, Mass., are the promoters.

The Covington Light and Power Company, of Covington, Ind., capital stock $50,000, has been formed to construct, maintain and operate an electric plant for light, heat and power, etc. Wm. S. Reed, Chicago, Ill.; Geo. M. Snyder, Noblesville, Ind., and Pierre Gray, Indianapolis, Ind., are the promoters.

The Berkeley Electric Light, Power and Heat Company, of Berkeley, Cal., capital stock $50,000, has been formed to establish and operate electric works, etc. A. A. Osborn, W. E. Sell, J. M. Whitworth, F. M. Cunningham, of Berkeley, and Jno. G. Mecredy, of San Francisco, are the incorporators.

The Presser Falls Land Company, of Presser Falls, Wash., capital stock $100,000, has been formed to operate electric light and water works, etc., etc. C. L. Smith, John Cellius, Seattle, Wash., A. K. Hiscock, Frank Allyn, H. H. Greeley, Tacoma, and Fred. B. Reed, of North Yakima, Wash., are the incorporators.

The River Valley Electric Railway Company, of Seattle, Wash., capital stock $250,000, has been formed to construct and operate an electric railroad, telegraph and telephone lines and electric light plants. The organizers are J. B. Thurston, J. S. Houghton, A. C. Schultz and E. J. Thurston, of Seattle, Wash.

The Ohio River & Chartiers Valley Passenger Railway Company, of Chartiers, Pa., capital stock $6,000, has been formed to operate and construct an electric railway in Esplen Borough and Chartiers. Andrew Patterson, Franklin P. Iams, both of Chartiers, and Wm. A. Zahn, of Crafton, Pa., are the promoters.

The Cleveland General Electric Company, of Cleveland, O., capital stock $25,000, has been incorporated to produce and sell electricity for light, heat and power, and to deal in electrical and other machinery, etc. The promoters are Andrew Squire, J. H. Dempsey, Lou. M. Snyder, Harrison B. McGraw and W. B. Whiting.

The Laredo Electric and Railway Company, of Laredo, Tex., capital stock $100,000, has been formed to produce and use electricity for lighting purposes, and to operate electric railways, etc. Carl F. Drake, Austin, Tex.; Ben. M. Hammond, San Antonio, Tex.; Chas. F. Yeager, Laredo, Tex., and E. S. Harris, are the promoters.

The Nevada County Electric Power Company, Grass Valley, Cal., capital stock $500,000, has been formed to generate electric light and power. Alphonse A. Tregido, Grass Valley; Hulbert H. Clark, Santa Cruz; John H. Moss, Alameda; Eugene J. C. Sabla, Jr., San Francisco, and Fred Searles, Nevada City, Cal., are the organizers.

The Trenton Light and Power Company, of Trenton, N. J., capital stock $760,000, has been incorporated to manufacture and use electric currents for light, heat and power purposes. J. Moses, S. D. Greene, New York City; F. A. Magewan, W. H. Allen, G. D. W. Vroom and S. K. Wilson, of Trenton, N. J., are the organizers.

The Paterson and Passaic Electric Railway Company, of Paterson, N. J., capital stock $40,000, has been formed to construct, maintain and operate a street railway. J. A. Morrisse, F. C. Van Dyk, J. R. Lee and A. H. Post, of Paterson, N. J.; C. A. Johnson, R. C. Johnson, and C. H. Russell, of Brooklyn, N. Y., are the organizers.

The Passaic, Rutherford and Carlstadt Electric Railway Company, of Paterson, N. J., capital stock $185,000, has been formed to construct, maintain and operate a street railway, etc. J. A. Morrisse, F. C. Van Dyk, J. R. Lee, A. H. Post, J. Scanlan, Paterson, N. J.; J. V. Morrisse, Passaic, N. J.; C. A. Johnson, R. C. Johnson, and C H. Russell, Brooklyn, N. Y., are the incorporators.

The North Shore Traction Company, Camden, N. J. capital stock $6,000,000, has been formed to construct, maintain and operate motors, cables and other mechanical or electrical appliances for the purpose of supplying motive power to passenger railways. The promotors are E. E. Denniston, J. P. Ilsley, Germantown, Pa.; C. F. Stevens, Philadelphia; S. E. Hass, Chester, and J. McNeill, Haddonfield, Pa.

The Cooper-Hampton Electric Company, of Minneapolis, Minn., capital stock $500,000, has been formed to manufacture electrical and other machinery and devices. J. Martin, J. S. Pillsbury, C. H. Chadbourne, C. H. Woods, L. Fletcher, S. C. Gale, P. D. McMillan, E. M. Johnson, J. M. Shaw, C. P. Lovell, F. C. Barrows, F. B. Winston, C. M. Loring, J. F. Conklin, W. Cooper, G. P. Hampton, A. C. Paul and F. N. Walcott, all of Minneapolis, are interested.

AFFAIRS OF THE COMPANIES.

Hartford, Conn.—The directors of the electric light company at a recent meeting considered the proposition of selling the plant to a syndicate of capitalists who, it is understood, will equip the street railway line with electric power. It is thought that the sale will be made.

The Hartford (Conn.) Light and Power Company is building a two-story brick extension to its works, and will install in the new building 156 feet of shafting with Hill clutches, two 3,000-h. p. Cooper-Corliss engines. The company also expects to install in the near future two 1,500-light incandescent dynamos as well as some arc-lighting machines.

The Lexington (Va.) Light and Power Company has just been organized by Lester Latham, J. C. Powell, and others of Baltimore, Md. The officers are: President, Lester Latham; secretary and treasurer, R. E. Hutton, of Johns Hopkins University; consulting engineer, E. R. Carichoff, formerly in the employ of Sprague, Duncan & Hutchinson, of New York. The company will use a dam on North River giving a working head of 10 feet, and 1¼ miles from the centre of the town. Existing contracts call for a plant of 50 arc and 800 incandescent lights to be in operation by Jan. 1, 1893.

Palmer, Mass.—The Palmer Electric Company has sold its plant and franchise for lighting Palmer and Monson to a company, the officers of which are as follows: President, George Flynt, of Monson; vice-president, C. L. Gardner; secretary, W. W. Leach; treasurer, C. B. Fiske, all three of Palmer. These officers, with C. E. Fish, of Palmer, and A. S. Young, of Waterbury, Conn., will be the directors. The plant will be removed to Blanchardville as soon as a building can be erected there, and the present plant will be enlarged at once. The Monson selectmen have contracted for street lighting with this company, and the work of setting poles and wiring will begin at once.

Special Correspondence.

NEW YORK NOTES.

Office of The Electrical World,
167-176 Times Building, New York, Oct. 10, 1892.

Mr. J. W. Marsh, general manager of the Standard Underground Cable Company, of Pittsburgh, Pa., was in New York on business last week.

Mr. Robert S. Dobbie, consulting electrical engineer, Times Building, New York City, has been appointed instructor in electrical engineering at the Pratt Institute, Brooklyn, N. Y.

Mr. Charles D. Shain, who was recently appointed Eastern agent for the Siemens & Halske Electric Company of America, has also been appointed the Eastern representative of the Sunbeam Incandescent Lamp Company.

Thomas H. Dallett, of T. H. Dallett & Company, of Philadelphia, while in New York last week, incidentally remarked that the Billberg motor was receiving its share of the patronage and the sales had largely increased of late.

Mr. Bernard Amend, of this city, has joined the forces of the Edison General Electric Company, and will occupy a position as expert at their plant in Schenectady, N. Y. The many friends of Mr. Amend will wish him success in this new departure.

Mr. P. H. Hover, manager of the Western office of the Standard Paint Company, was in New York for a few days on business. This company's P. & B. specialties are to be used for all moldings in the World's Fair buildings, and its new machine for painting moldings is being received with great favor.

The Mayor Refuses to Sign the Trolley Franchise.—Mayor Grant has signed all the franchises granted by the Board of Aldermen to the Metropolitan Traction Company, except the one for the Ninth Avenue line. In a communication to the Board he requests it to recall that franchise and pass one which expressly prohibits the use of the trolley system.

Brooklyn Insitute Lectures.—A lecture was given at the Brooklyn Institute of Arts and Sciences on Oct. 7 by Mr. J. H. Gerry, of New York, on "Recent Improvements in Electrical Clocks." In the Department of Physics a lecture will be given on Oct. 11 by Prof. William LeConta Stevens, Ph. D., formerly president of the department, now of the Rensselaer Polytechnic Institute, on the Physical Laboratories in Germany and Switzerland, illustrated by lantern photographs. L. H. H.

PHILADELPHIA NOTES.

Philadelphia, Oct. 8, 1892.

The White Dental Company will soon be out with a catalogue descriptive of this improved primary battery.

Moore's Fire and Weather-Proof Wire will be used in wiring the Philadelphia county prison, the contract for which has been awarded to Walker & Kepler.

Mr. George Vallee, of the firm of Vallee Bros., recently returned from a Southern trip, where he has been very successful in placing several hundred of the Vallee mica insulating joints.

The Globe Electric Cordage Works, Philadelphia, Pa., has disposed of its plant, including machinery, materials, patent rights, etc., to Alfred F. Moore, Third and Race streets, Philadelphia.

The Howard Foundry and Machine Works is now making an improvement in its electric elevator, on an entirely new principle, and claims to have overcome all the objectionable features said to exist in those now in use.

Morris Tasker & Co., manufacturers of wrought iron street railway poles, has completed a contract of furnishing the Baltimore Electric Railway system with 800 wrought iron shrunk joint pipe poles. This company also has the contract for furnishing the New Orleans Street Railway Company with 2,000 poles of the same kind.

H. M. Sciple is unusually busy in the engine and boiler business, having received this week from Huntington, W. Va., an order for a 600-h. p. Hamilton Corliss engine; an $8,000 order for Sciple boilers from Mackinaw City, Mich., Electrical Light Companies; the Brightwood Street Railway Co., Washington, D. C., orders three Cooper engines; besides several other smaller orders.

Westinghouse apparatus will be used in the Masonic Temple building plant, Camden, N. J. The size of this plant is 1,000 lights and it is to be installed by Pepper & Register. This company is also putting in the apparatus and special switchboard work, cement work, drainage, etc., complete, of the isolated plant for the University of Pennsylvania, where three different types of engines and dynamos will be used. The Union League is also being equipped by this company with 1,000 light plants of Waddell-Entz apparatus. W. D. W.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 28, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., Oct. 8, 1892.

Mr. Fred C. Russell, representing the Economic Electric Company, of Brocton, was a recent visitor to this office.

Springfield, Mass.—The street railway company is to introduce the Burton electric heater on some of its cars, and if it proves successful it will heat all of its cars by this method.

M. S. Starkweather, of Boston is introducing what he calls the Boston car fender. This is the latest thing of its kind and has rollers on the bottom so that it does not engage with the obstacle, and as it has a vertical action it cannot do injury.

The Dover (N. H.) Union Street Railroad stockholders elected the following directors at their recent meeting: Edw. Wallace, of Rochester, N. H.; Harrison Haley, Frank A. Christy and Isaac F. Abbott, of Dover, N. H.; and Henry W. Burgett, of Brookline, Mass.

The New England Electric Club will hold its regular meeting at the Club House, No. 14 Bosworth street, on Tuesday evening, Oct. 11. As matters of vital importance to the club will be considered, it is highly important that every member should be present. A first-class musical entertainment will be provided and refreshments served.

The East Middlesex Street Railway Company has increased its capital stock 50 per cent. to $300,000, and shareholders of Sept. 23 are privileged until Oct. 24 to take one new share at par, $100, for each two shares now held. Payment will be 25 per cent. Oct. 24 and the balance after Jan. 1, as determined by the directors. As the stock lately sold at 106, a right of some value attaches to the privilege, and said rights become a proper subject for dealings in the market. They are worth some $2.00 each.

The Rollins Engine Company, Nashua, N. H., has issued a neat folder giving a good illustration of its engine and describing its adaptability to the electric lighting service. This engine is of the four valve liberating valve gear type and is designed to fully supply the requirements of modern engineering. It is designed to work under a high steam pressure and at a moderate speed of 450 feet of piston travel per minute or a high speed of 700 feet. The working parts are constructed so as to take up the wear and with a view to stability and minimum amount of repairs. The governor is constructed on scientific principles and controls the engine perfectly, giving a uniform speed under the most trying variations of load and pressure. These engines are made in sizes from 30 to 600-h. p.

The following concerns are making very handsome displays at the Mechanics' Fair which is being held in this city: The Goubert Manufacturing Company of New York is exhibiting its various sizes of water tube, feed water heaters; Parker, Field & Mitchell, of Cambridgeport, are showing their celebrated hoisting engines; the Brainard Milling Machine Company, of Hyde Park, has a line of milling machines of various sizes; the Walworth Manufacturing Company is making a very creditable display, Morse & Whyte, manufacturers of the Simplex Wire, are also on hand; the Wainwright Manufacturing Company has one of the most attractive exhibits in the Machinery Hall and the Beacon Vacuum Pump and Electrical Company is preparing an elaborate display. Other firms who are exhibiting are Westinghouse, Church, Kerr & Co., Messrs. Otis Bros., of New York; John Becker Manufacturing Company, of Fitchburg; F. E. Reed & Co., Worcester, Mass., and Geo. T. McLauthlin & Co., Boston. As the Fair progresses it is expected that there will be considerable electrical apparatus exhibited. W. R. W.

WESTERN NOTES.

Branch Office of The Electrical World,
465 The Rookery, Chicago, Oct. 8, 1892.

Mr. Scott Van Ettin, formerly of the Omaha Consolidated Electric Company, has formed an electrical construction company in Houston, Tex.

The Inland Architect for October contains illustrations of George Cutter's handsome residence just completed in one of the Chicago suburbs.

Mr. E. E. Drake, general sales agent of the Standard Electric Company, of Chicago, will shortly visit Eastern points in the interest of his company.

Mr. and Mrs. Sterling, of Denver, visited the St. Louis Exposition this week while en route west from an Eastern trip. Mr. Sterling is the electrician of the Denver Consolidated Electric Company.

The Commercial Electric Company, 113 S. Tennessee street, Indianapolis, Ind., is in the market with the Adams dynamos, motors and motor-generators, and has already booked several orders for these efficient machines.

The Standard Electric Company, of Chicago, will light up the important buildings during the dedication ceremonies of the World's Fair, and already has a number of its dynamos in position and several hundred arc lamps on the grounds.

Mr. C. K. MacFadden has just finished superintending the wiring of the handsome new depot of the Chicago & Northwestern Railway Company at Council Bluffs, Ia., and has also arranged to use 1,100 feet of flexible Habirshaw insulation for the arc-light circuits on the iron ore docks at Escanaba, Mich., where more or less annoyance has been caused by "grounds," owing to the large amount of fine iron-ore dust that gathers on almost every conceivable part of the circuit.

Among the World's Fair Visitors from out of town this week were Mr. Clifford Holbrook, vice-president of the Canton Steel Roofing Company, Canton, O.; Mr. A. D. Adams, general manager of the Commercial Electric Company, Indianapolis, Ind.; Mr. F. B. H. Paine, of New York City; Mr. Charles Wilson, the Northwestern representative of the Babcock & Wilcox company, with headquarters at Minneapolis, Minn.; Mr. Dilworth Richardson, general manager of the Carpenter Electric Heating Manufacturing Company, of St. Paul, Minn., and Mr. J. B. Wallace, of Wallace & Son's, Ansonia, Conn.

Mr. A. D. Adams, late general sales agent of the Jenney Electric Motor Company, has severed his connection therewith, and assumed the general management of the new Commercial Electric Company, lately organized in Indianapolis, Ind. Mr. Adams has already equipped his factory with the latest improved machinery, and will manufacture incandescent dynamos and motors designed under his patents, and has already been so fortunate as to secure orders for some of these machines. Mr. Adams' wide experience with the Thomson-Houston, the Mather, the Brush and the Jenney Electric companies, both in the shop and the field, will stand him in good stead and will probably insure success from the start.

Permanent Park Illumination.—Forming a part of the preparations that the public-spirited citizens of Chicago are making with a view to having the city present an appearance in keeping with its world-wide fame when the gates of the World's Fair are thrown open, is the permanent lighting system for Washington Park and the principal boulevards leading thereto, a system that will enable these beautiful driveways to be used on the darkest nights when visitors are proceeding to or returning from Jackson Park, or are out for an evening drive. The South Park Commissioners, who have control of Jackson Park, the Midway Plaisance and Washington Park, decided to expend about $150,000 in a permanent lighting plant, and contracted with the Brush Electric Company for the complete installation of 260 double-carbon Brush arc lamps of 2,000 c. p., with necessary dynamos, etc. This plant is fast approaching completion, and will consist of a special brick building with trussed roof, erected by the Park Commission, in which are placed six 50-light Brush dynamos, thus affording a large reserve capacity, that are belted direct to three Fraser & Chalmers Corliss, non-condensing, cross-compound engines of about 110-h. p. each at 140 revolutions. The steam for operating the engines is supplied from three Campbell & Zell water tube boilers. An enamel slate switchboard is arranged for eight dynamos and eight circuits and will be equipped with the Brush Electric Company's new device for locating grounds or leaks. An underground system of circuits is used exclusively, the 30 miles of heavy insulated No. 5 B. & S. New York safety cable having a

three-sixteenth inch wall of rubber encased in lead, being drawn into steel pipes of from one and one-half inch to two inches in diameter laid underground and connected to the cemented brick and hand holes, and to the pyramidal lamp post bases built of concrete blocks, five feet deep and three feet square at the base. To these substantial bases are bolted ornamental cast iron lamp posts, 18 feet in height, having an artistic curved arm extending out four feet, and the posts are so set that the lamp will overhang the driveway two feet beyond the curbing. These lamps are placed in service in Washington Park and along Grand, Oakwood, Drexel and Garfield boulevards, and the avenues bordering on the park, the distance between the lamps being about 300 feet along the park driveways, while on the boulevards four lamps are placed in each block of about 600 feet, which insures the thorough lighting of one of the most attractive driveways in the country. F. DE L.

TACOMA, Wash., Oct. 3, 1892.

An electric railway has been proposed, to run along the beach at Gray's Harbor, Washington, and extending to the new watering places on the Pacific Ocean.

The American District Telegraph Company has ordered 100 new call boxes, which have been shipped, and will increase the number in use by the company in Seattle to 800.

The Commercial Electric Light and Power Company, of Tacoma, has just installed a 100-light electric plant in the new woolen mills in this city. An Edison 115 volt dynamo, Thomson-Houston sockets and Buckeye lamps are included in the equipment

The Portland-Oregon City Electric Line, which is being built southward from Portland, is now in operation to Oak Grove, two and a half miles beyond Milwaukee. Tracklaying is proceeding vigorously and the road will soon be in operation to Oregon City.

L. F. Cook, of Tacoma, has a working model of his electric system in operation at the Western Washington Industrial Exposition in Tacoma. Two overhanging cars speed around a circular track, passing on the opposite sides of the poles which support the structure.

Rudolph Hering, C. E., has arrived in Tacoma to examine and report upon the value of the Tacoma Light and Water Company's electric light and water systems wich a view to their purchase by the city. He will also advise the city as to increased sources of water supply.

The Seattle Gas and Electric Company now has the following officers: President, Hon. H. G. Struve; vice-president and general manager, John Mather, formerly of St. Paul; secretary and treasurer, L. Turner; trustees, H. G. Struve, Col. G. M. Neison, John Mather, R. C. Elliott, L. Turner. Capt. Penfield retired with the old management.

The Consolidated Electric Railway and Electric Light Company, of Everett, Wash., Col. J. B. Hawley president and manager, is pushing its business in accordance with its liberal franchises. Its capital stock is $200,000. It was required to begin work within 90 days on the Hewitt Avenue Railway line, and also on 10,000 feet of electric light wire to be strung within a year. Electric railway lines are to be built on Hewitt, Pacific and Everett avenues, Broadway, McDougal and Chestnut streets.

The Seattle Board of Public Works recently opened the following bids for supplying a city electric lighting plant: Union Electric Company to sell its present plant for $79,500; a second proposition for $86,600; Charles H. Baker & Co., proposition "A," $66,900; "B," $64,400; "C," $70,200; A. L. Kasson, agent, $60,745; Northwest General Electric Company, No. 1, $83,280; No. 2, $88,280. They were referred to the City Council, which failed to agree upon any propositions. Later bids are to be called for to light the city for a term of six months, pending further action as to a city plant. G. R. DE V.

ENGLISH NOTES.

(From Our Own Correspondent.)

LONDON, Sept. 28, 1892.

The Gilbert Club.—It is announced that the main work for which the Gilbert Club was founded, namely, the production of an English version of "De Magnete," is approaching completion, and that the work will shortly be published.

Electrical Resistance of Alloys and Metals at Low Temperatures.—I hear that Profs. Fleming and Dewar have been carrying out some investigations on the specific resistance of metals and alloys at the temperature of boiling oxygen (—197 degrees C.). The increase of conductivity of these temperatures is said to be very striking.

Electric Lighting in Spain.—The newspapers report severe thunderstorms in Spain, and state that at Aguilar, near Cordova, the inhabitants, owing to the fusing of some of the electric light mains by lightning, decided that the presence of these wires had a malign influence upon the town, and promptly cut down a large portion of the electric light company's system.

Lighting of the Houses of Parliament.—Considerable interest is attached to the work of redecoration, which is now going on in the House of Lords. The decoration has not been touched since its erection in 1847; the carving and gilding being of so elaborate a character that the House has earned the title of the "gilded chamber." It is remarkable, that although gas has been the illuminating agent during the whole of this long period, the original gilding when deprived of its coat of dirt has been found to be absolutely uninjured. This result is perhaps due in some measure to the excellent system of ventilation employed, which is such that the hot stream of vitiated air ascending from the gas burners is largely prevented from impinging on the ornamental work itself. The House of Lords will in future be lighted by electricity, and this addition to the electric light installation will increase the total number of lights in Westminster Palace to about 2,000.

Electric Lighting Contracts.—In view of the many miniature "wild cat" schemes on foot in the United Kingdom, especially in Ireland, it is perhaps some consolation to note that much the same sort of thing appears to be prevalent in France. According to a statement which has appeared in the French technical press, an extraordinary muddle has been made over an electric lighting scheme in the south of France. A 200-h. p. waterfall, difficult of access, existed some four or five miles outside the town in question. Although the ultimate load of the proposed central station might reasonably be anticipated to reach some 20,000 lamps, and therefore the 200 h. p. of the waterfall would furnish but an insignificant portion of the total power likely to be required, it was decided to install the generating plant at the waterfall, thus burdening the undertaking from the commencement with heavy copper losses, the cost of a long line of conductors and high charges of coal cartage. To further complicate matters two systems of distribution were employed, the centre of the town being lighted by the continuous current battery storage system and the rest of the town being supplied by alternating currents, the battery being charged, I may add, at an electromotive force of only 400 volts. The cumulative result of all these absurdities is that the company has come to grief before it has come into operation, and the houses that have been wired are still awaiting a supply of current.

News of the Week.

THE ELECTRIC LIGHT.

Christiana, Pa., is to be lighted by electricity.

Carson City, Mich., is putting in an electric light plant.

The Climax Road Machine Company, of Marathon, N. Y., is making arrangements to put an isolated plant in its factory.

Kittanning, Pa., is to be lighted by electricity, a local company having agreed to furnish twenty 2,000-c. p. arc lights at $60 per year.

New Richmond, Wis., has let its contract for a complete system of arc and incandescent lighting to the Northwestern General Electric Company.

Middletown, Pa., has awarded the contract for the electric light plant to the Pennsylvania Electric Co., and the Thomson-Houston system will be used.

Baltimore, Md.—The 70-foot steel water tower, in Roland Park, is to have an addition of 30 feet, on top of which will be placed two 10,000-c. p. electric lights, which it is expected will be seen a distance of 20 miles down the bay.

The rumor that the General Electric Company intends to divide among the loyal and faithful who always religiously bought Edison's lamps the money they may collect from those who persisted in purchasing lamps of other manufacturers cannot, unfortunately, be verified.

Illumination of the Goddess of Liberty.—Experiments have been made with the new gigantic reflector which has been installed for the purpose of illuminating the face of the Goddess of Liberty, and it brings out the features more distinctly even than was expected.

The Whirligig of Time brings many changes. When a few years ago Mr. George W. Stockley sold the American Electrical Company, afterward known as the Thomson-Houston, for $60,000, history says he returned to Cleveland with an exceedingly broad and pleased smile of satisfaction. The same company subsequently absorbed Mr. Stockley's own company, the Brush, and followed this up by also absorbing its competitor, the Edison. If the Edison had only been under more capable management—if it had only waited until the lamp decision—how different might have been the terms of consolidation!

THE ELECTRIC RAILWAY.

San Diego, Cal.—A new electric railroad is now in operation. It is equipped with double decked cars.

West Springfield, Mass., has petitioned the street railway officials to equip the West Springfield line with electricity.

The Columbia & Ironville Electric Railway Company has purchased the property on Commerce street, Columbia, Pa. formerly occupied by the agricultural works, and will erect thereon a power house and car shed. Work will be commenced immediately, and it is intended to have the road in actual operation by Jan. 1.

The St. Louis & Chicago Air Line.—A gang of 200 workmen under the charge of Andrew F. Burke, an old railroad contractor, have proceeded to Edinburgh, Ill., from St. Louis, where they will commence the construction of the road bed for the St. Louis & Chicago electric railroad. Work will be pushed in both directions and it is hoped that a portion or the whole of road will be in operation at the time of the opening of the World's Fair.

LEGAL NOTES.

Electric Light Companies Are Manufacturers.—Electric light companies, or rather corporations, engaged in generating, storing, transmitting and selling the electricity now used and applied in the ordinary business of life are manufacturing corporations, and entitled to the privileges of such corporations, because such electricity is essentially the product of skill and labor. Thus they may consolidate under a statute like that of Alabama providing that "any two or more mining, quarrying or manufacturing corporations may unite or consolidate their capital stock, property and business." This is following the case of the People v. Wemple, decided by the New York Court of Appeals not long ago to the effect that a corporation engaged in the business of generating and supplying electric currents for illuminating and other purposes is within the New York statute exempting from taxation manufacturing corporations carrying on manufactures within the State. This decision was rendered in the case of Beggs v. Edison Electric Light Illuminating Company in the Supreme Court of Alabama.

Liability of Principal to Third Parties.—The Baltimore & Ohio Railroad Company, having power to transact a general telegraph business, and being the owner of an extensive telegraph system, caused the Telegraph Company of Baltimore County to be incorporated with a small capital, and in its name made a contract with the complainant. For breach of that contract the complainant recovered judgment against the Telegraph Company of Baltimore County. The Baltimore & Ohio Railroad Company sold out its whole telegraph system to the Western Union Telegraph Company, and the Telegraph Company of Baltimore County was left without assets of any kind, and became insolvent. It was held that as the railroad company was the stockholder of the Telegraph Company of Baltimore County, and appointed its officers, and held it out as having authority to contract with regard to the whole system owned by the railroad company, the Telegraph Company of Baltimore County was a mere agent of the railroad company, a mere name, in fact, under which the railroad company conducted its telegraph business, and that under the circumstances of this case a court of equity had jurisdiction to decree that the railroad company, as principal, should pay complainant's judgment against its agent, from which it had taken all the property which it had represented that its agents controlled. This decision was rendered in the case of the Interstate Telegraph Company v. Baltimore & Ohio Telegraph Company of Baltimore County in the United States Circuit Court, Circuit D, Maryland.

MISCELLANEOUS NOTES.

Accident in an Electric Light Station.—A four-ton flywheel recently flew to pieces at the Sioux City (Ia.) Electric Light Works, and the fragments of the wheel did considerable damage in the station.

The Akron (O.) Twine and Cordage Works has resumed operations again after the usual closing for the summer. Quite a radical departure is noticeable in the employment of electric motors for driving the machinery on the first floor of the factory.

The New York Gaynor Electrical Company gave a reception to the visiting fire chiefs at Exhibition Hall, Louisville, Ky., on Tuesday, Oct. 5. Many favorable comments were made upon the Gaynor fire alarm apparatus, which was on exhibition there.

Underwriters Sue an Electric Light Company.—The Louisville (Ky.) Gas and Electric Light Company has been sued by the insurance companies interested in the Kaufman, Straus & Co. claim for $250,000 on the ground that the fire resulted from negligence on the part of the Gas and Electric Light Company.

Industrial and Trade Notes.

The Railway Register Company, 1,193 Broadway, reports business very active and numerous orders for railway registers and bell punches. The firm is crowded to its full capacity with contracts.

The Bradbury-Stone Storage Battery Company, Western, has issued a prospectus, setting forth the advantages of the storage battery, both for lighting and for motive power of all sorts, as well as for medical and surgical purposes for use with the phonograph, graphophone, telephone, electro-plating, etc.

Messrs. Davis & Cooke, Watertown, N. Y., have issued a new catalogue of their levels, which are unusually well made and very ornamental in appearance. Their railroad track levels are perfect in adjustment and the edges are carefully protected by iron. Street railway contractors will find them of great use.

The Mason Regulator Company, 10 Central street, Boston, Mass., is sending out a unique parchment giving a map of "The supposed world previous to the discovery of America by Christopher Columbus," showing "the true location of the Mason Regulator Company, which together with all the rest of America was unknown to those ignorant geographers of 1492."

The Purity Oil Filter Manufacturing Company, of Pittsburgh, Pa., has just issued a new eight-page folder, giving facts and figures about the ideal steam oil refiner, which that company claims is the surest and safest oil purifier in the market. Their statements are indorsed by testimonials from numerous electric light and street railway plants and by the large amount of business which the company continues to hold.

James Trimble, 218-222 East Twenty-eighth street, is a car manufacturer whose work has justly gained a reputation for its excellence. This large plant is now turning out electric cars for Jersey City, for the Metropolitan Railway Company, of Washington, D. C., where the storage battery is used, and for the filling of a number of other very large contracts. It is thought that it will be necessary in the immediate future to enlarge the already extensive plant.

Mr. William A. Rosenbaum, electrical expert and patent solicitor, Times Building, N. Y., is sending out a handsomely illustrated pamphlet entitled "Inventive Progress," which contains a description of the U. S. Patent Office and information as to what is patentable, beside illustrations and descriptive matter of the famous patents of the century, with their inventors. Some idea of the enormous sums which have been realized from some of the more important patents is also given.

The C. S. Flush Face Push Switch is one of the latest specialties which the Electric Appliance Company, of Chicago, has handled so successfully. This switch is being used for fine residence and office work. The combination branch block is another one of the Electric Appliance Company's new specialties. It is made of one piece of porcelain with a handsome polished hard wood cover and takes the place of eight ordinary branch blocks. The Reis regulating socket is also handled by this company.

The Detroit Electrical Works some time ago equipped the Jefferson avenue line in Detroit, Mich., with its apparatus and this line has worked so successfully that the company has now secured, in the face of strong opposition, a contract for the equipment of the Woodward avenue line of the Detroit City Street Railway Company. The Detroit Electrical Works is to furnish poles, wires, motors—in fact the complete equipment—which will cost in the neighborhood of $100,000. The cars are to be built by the Pullman Car Works and will be of unusually fine workmanship. The contract calls for the completion of the road in 45 days. The Detroit Electrical Works has also received a sixth order from the Calumet Electric Street Railway Company, of Chicago, and has also been awarded the contract for the equipment of the Consolidated Electric Street Railway Company's lines at Salina, Kan. Notwithstanding the fact that its factory has been enlarged so as to increase its capacity nearly threefold the company is overcrowded with orders for its standard railway equipments and railway generators.

The Nicholson File Company is sending out an ornamental placard, and some little folders describing the increment cut and X. F. files of this well-known company. More than 3,000 varieties of files are now manufactured by this firm, and have come to be recognized as standards for all classes of work. The increment cut file possesses many advantages over the common form, as the following extract from Johnson's New Universal Encyclopedia shows: "The difference between this, and the perfect regularity of other kinds, must be apparent, particularly in double-cut files; as in the one case the file cut with such extreme regularity, when put to use, will, in the first inch of its movement, produce channels or grooves, and these grooves will continue to be made deeper as the file is shoved along, thus producing that "grooving" and "chat, ting" so often complained of; while with the increment cut file the grooves made by the movement of the file for the first inch will have their sides cut away, as the file is moved toward the tang or handle, and vice versa." The X. F. files are intended for the use of jewelers, watchmakers, silversmiths, and for other purposes where a very fine quality of files is required.

The Danforth Belting Company.—Not only is Philadelphia a large consumer of such goods as leather belting, lace leather, etc., but she is extensively engaged in the manufacture of such articles. Among the most prominent firms in this line is the Danforth Belting Company, now located at 221 Chestnut street, where it recently removed from 118 Knox street in order to secure better facilities and more commodious quarters. This business was first established by Mr. D. Danforth and others 27 years ago. It was continued for some time under the name Danforth & Wise, when it was changed to D. Danforth and conducted under that name until the death of the promoter, when the firm name was again changed to the Danforth Belting Company. For years the company has obtained its oak-tanned hides from the well-known firm of England & Bryan, Philadelphia. The Danforth Company makes a specialty of dynamo belting and the following list of sales testifies to its success: The Southern Electric Light Company, Chambers Bros. & Co., Craven & Dearnly, M. A. Furbush & Son Machine Company, Barnes & Beyes' Worsted Mills, Philadelphia, and Chambers Bros. & Co., West Philadelphia; the Georgetown Electric Railroad Company, Washington, D. C. W. T. & F. B. Weaver, 1,208 and 1,212 Thirty-second street, Washington, D. C., have been appointed agents of the Danforth Belting Company for that district.

Warren Webster & Co., 491 North Third street, Philadelphia, Pa., sole licensees for the Williames Vacuum System of Steam Heating without back pressure upon the engine, and proprietors and manufacturers of the Webster Vacuum Feed Water Heater and Purifier, report the following orders during the past month of September: Enterprise Machine Company, Minneapolis,

Minn.; Burtis, Patterson, Sargent Paint Company, Cleveland, O.; Oatman Bros., Dundee, Ill.; Armour & Co., Chicago, Ill.; Morrisson Plummer Company, Chicago, Ill.; Racine Hardware Company, Racine, Wis.; National Casket Company, Hoboken, N. J.; E. Z. Wallower, Joplin, Mo.; Republic Iron Works, Pittsburgh, Pa.; American Hosiery Company, New Britain, Conn.; Escanaba Lighting Company, Escanaba, Mich.; Union Wire Mattress Company, Chicago, Ill.; Wilson Distillery Company, Highspire, Pa.; Watsontown Boot and Shoe Company, Watsontown, Pa.; United States Iron and Tin Plate Company, Demmler, Pa.; Germantown Spinning Company, Germantown, Philadelphia, Pa.; Western Electric Company, Chicago, Ill.; The Swift Manufacturing Company, Columbus, Ga.; Swift & Co., South Omaha, Neb.; Swift & Co., Chicago, Ill.; Chas. T. Bainbridge's Sons, Brooklyn, N. Y.; Bamford Bros., Paterson, N. J.; H. P. Nail Company, Cleveland, Ohio.; Pencoyd Iron Works, Pencoyd, Pa.; Mechanical Fabric Company, Providence, R. I.; Société Anonyme, Antwerp, Belgium; Jonathan Clark Building, Chicago, Ill.: Knight & Jillson, Indianapolis, Ind.; Detroit Sheet Metal and Brass Works, Detroit, Mich.; Smith Building, Chicago, Ill.; The Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa. They have just issued a new catalogue.

The Short Electric Railway Company, of Cleveland, O., has received the following letter from the engineer in charge of the Collins Park & Belt Line Railway Company, Atlanta, Ga.: "The E. T. B. & G. R. R. delivered our generator at the W. & A. R. R. through an error. The W. & A. carried her out to the new water works, 16 miles from the city. Hunting her up and getting her back to the G. P yards delayed me in setting her up. Took her out to the power station last Friday evening. Unloaded her and set the base on Saturday. Put her together on Sunday. Wired her up on Monday and started her on Tuesday. The company did not have an engine and it would have been very costly for me to haul the generator to the station by wagon. Besides, some parts of the road would have had to be fixed up. In all I believe it would have cost $40 or $50 to haul her four or five miles to the plant. Therefore, I hitched an electric car to the flat car containing the generator and started for the plant. It made a heavy load, but I got there safely. On the steepest grade we went along faster than a man could walk, and you know we have some pretty stiff grades on this road, fully 6½ per cent. I think. The motors got pretty warm, but not more so than I have seen them during heavy traffic. The work done by them is remarkable and is the talk of the town." The following additional information is of interest: Pennsylvania Railroad Company car No. 5,653, weight 23,150 pounds; Short 150-h. p. generator, weight 24,000 pounds; total weight, 47,150 pounds. Between the Georgia Pacific Railroad Company and the power station of the Collins Park & Belt Railway Company there is one grade of 5 per cent. and another of 6½ per cent. The distance between the two points is 4½ miles. The motive power was one 16-foot open car body, equipped with two 20-h. p. single reduction Short railway motors.

Business Notices.

Transformers rewound and repaired. Write for prices. The Hill Manufacturing Company, Salem, Va.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Every One Interested in Electrical Work Should Have One.—Mr. T. R. Anson, of Portland, Ore., states that he is well pleased with the new edition of Houston's "Dictionary of Electrical Words, Terms and Phrases," and that "every one interested in electrical work in any way should have one."

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

[In Charge of W. A. Rosenbaum, 177 Times Bldg., N. Y.]

U. S. PATENTS ISSUED OCT. 4, 1892.

483,515. Electric Fan; Elisha B. Cutten, New York. Application filed May 22, 1891. A portable electric fan comprising a base, an electromotor enclosed in the base, a tubular handle attached to the base and projecting upwardly, by means of which the motor may be lifted, a vertical revolving shaft passing out from the base through the tubular handle connected within the base to the motor, so as to be driven thereby, and a fan mounted on the shaft.

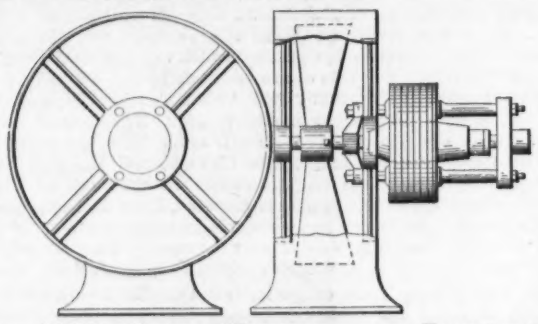
483,562. Storage Battery; Edward R. Knowles, Brooklyn, N. Y. Application filed Oct. 15, 1891. In a storage battery, an electrode formed of a series of parts, each part consisting of a hollow box or cell with thin perforated walls filled with absorptive material, the boxes or cells being arranged to form the primary element.

483,563. Storage-Battery; Edward R. Knowles, Brooklyn, N. Y. Application filed Oct. 15, 1891. An electrode for electric accumulators, consisting of a series of containing rays or boxes arranged in a column, one on top of another, in combination with a bottom strip, provided with supporting feet.

483,582. Motor Mounting for Electrically Driven Fans; Andrew L. Riker, New York. Application filed Dec. 22, 1891. This invention consists of a casing surrounding a fan and mounted on a suitable support, a ring-plate on one side of the casing and forming part thereof, an electromotor having its frame secured by detachable bolts to the outside of the ring plate and wholly separated thereby, and a shaft carrying the armature of the motor and also the fan, the shaft passing freely through the plate, and having a removable journal-bearing at its outer end, so that the shaft and magnet-frame are each removable without disturbing the other. (See illustration.)

483,625. Electrical Burglar Alarm; Homer T. Wilson, Louisville, Ky. Application filed June 9, 1892. This invention consists of an alarm bell, a single source of energy, and an open and a closed circuit, whereby the opening or breaking of the closed circuit will cause the bell-armature to fall back and close the open circuit through a vibrator spring.

483,646. Process of Making Artificial Mica Sheets for Electrical Insulation; Arthur H. S. Dyer, Schenectady, N. Y. Application filed June 1, 1892. A method of building up electrical insulating mica sheets, consisting in varnishing a foundation plate; placing mica scales thereon while the varnish is still wet or soft with their edges overlapping, varnishing the mica sheets, thus forming a second and third, etc., layer of mica in a similar manner until the required thickness of mica sheet is obtained, and chilling the sheet while rigidly held in a curved position.



No. 483,582.—Motor Mounting for Electrically Driven Fans.

483,653. Molding Mica Forms for Electrical Insulators; Charles W. Jefferson, Schenectady, N. Y. Application filed June 1, 1892. A process of building and setting mica sheets, consisting in building a mica sheet by cementing together laminæ of mica scales with overlapping edges, compressing the sheet into the desired form while the cement is wet, drying the cement by evaporating the solvent thereof, and finally chilling the molded mica sheet while under compression.

483,654. Galvanic Battery; Harry T. Johnson, New York. Application filed Dec. 10, 1891. A galvanic battery having the exciting agent and the depolarizing agent arranged alternately in horizontally disposed strata within the cup-shaped positive electrode. (See illustration.)

483,689. Trolley-Catcher; John J. Hoppes, Springfield, O. Application filed Feb. 24, 1891. A trolley-arm provided with a broken or flexible portion having an independent movement with reference to the solid or main portion, a flexible cord of a definite length connected at one end to a stationary part and at another to operating mechanism adapted when released to shorten the cord, and thus withdraw the trolley arm, and a catch to release the mechanism by an independent movement of the flexible portion.

483,692. Electrolytic Diaphragm; Anton J. Lehman, New York. Application filed July 6, 1891. A separating diaphragm or partition for an electric battery or electrolytic cell of an amorphous non-gelatinous precipitate, combined with a holder, precipitated or impregnated before use in an electric battery or electrolytic cell, which precipitate is not dependent upon the solutions subsequently used in an electric battery or electrolytic cell.

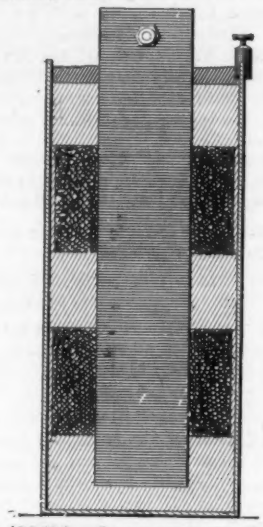
483,700. Armature for Dynamos and Motors; Elihu Thomson, Swampscott, Mass. Application filed Dec. 2, 1891. The combination, with the annular magnetic core having one or more notches and filling plugs, and having projections on its surface, of the separable coils of a size and shape enabling them to be passed through the notch and over the projections, the coils being secured in place between such projections by a bearing against the armature.

483,704. Electric Switch; David H. Armstrong, Long Island City, N. Y. Application filed June 11, 1892. A switch for electric circuits, composed of an insulating base, a centre post having a thumb-piece at the outer end and a square inner end, a sleeve on the post, means for connecting the post with the sleeve, a segmental cam on the sleeve, a contact spring connected with the main line, placed in contact with the square end of the sleeve, and two contact springs adapted to be moved in or out of circuit with the cam, so that either one or both lighting circuits can be placed in circuit with the main line.

483,708. Armature for Motors and Generators; Norman C. Bassett, Lynn, Mass. Application filed Feb. 27, 1891. An armature having an interior core and surface sections attached to the said body, extending out over the coils, and meeting at the surface, so as to completely inclose the coils and form a closed surface.

483,712. Electric Switch; Axel Ekström, Lynn, Mass. Application filed Nov. 10, 1890. The combination, in an electric switch, of a contact-maker and spindle with the fixed cam thereon and the reversely shaped non-rotating cam spring pressed into engagement with the fixed cam, the cams being provided with locking lugs to prevent turning the spindle backward.

483,713. Electric Snap-Switch; Axel Ekström, Lynn, Mass. Application filed April 7, 1891. In an electric switch, the combination, with the fixed contact-surfaces, of a reciprocating bridging springplate movable perpendicularly to the surface to press against or be withdrawn from same and having outwardly and downwardly extending ends.



No. 483,654.—Galvanic Battery.

483,718. Telephone-Receiver; Ferdinand Gross, Montreal, Canada. The combination, with a telephone-receiver, of a compressible cushion held in place with one side bearing against the face of the receiver by a detachable flexible connection.

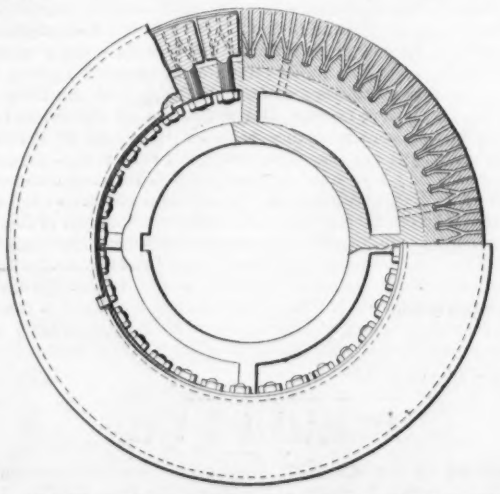
483,725. Hygrometric Valve-Controller; Charles W. Rogers, Chicago, Ill. Application filed Dec. 14, 1891. The combination, with a measuring device adapted to be operated by changes in humidity of the atmosphere, of suitable air moistening devices provided with valves and suitable connecting devices through which the valves may be operated by the measuring device.

483,728. Electric Burglar Alarm; Alfred Stromberg, Chicago, Ill. Application filed March 15, 1892. In an electric burglar alarm circuit, the combination, with a flexible surface, or a series of pliable conducting strips, the strips being folded longitudinally, and attached by one of the free edges thereof to the flexible surface, and electrical connections between the strips.

483,729. Armature-Winding for Dynamo-Electric Machines; Ernest P. Warner, Chicago, Ill. Application filed Sept. 30, 1889. The combination, with the armature-core, of coils wound thereon in uniform relation with respect to the different turn, the two halves of each turn upon the face of the armature being removed from diametrical position by the thickness of the wires.

483,732. Commutator for Electric Machines; Norman C. Bassett, Lynn, Mass. Application filed Aug. 26, 1891. The combination in a commutator, of a shell or cylinder having an annular shoulder or bearing surface, a series of independently adjustable clamping devices, and a series of commutator segments embraced between each shoulder and clamping devices. (See illustration.)

483,739. Door-Lock Switch for Electric Lights; Charles Green, Toronto, Canada. Application filed April 8, 1892. In a door-lock switch for electric lights, a switching piece pivoted in the keeper and having one end located between the conducting wires and held normally out of contact therewith, and the other end adapted to be operated by the bolt of the lock to close the circuit.



No. 483,732.—Commutator for Electric Machines.

483,758. Electrical Heater; Arthur E. Appleyard, Boston, Mass. Application filed Sept. 14, 1891. An electric heater composed of a solid and rigid resistance rod having an externally exposed coating of water-proof vitreous material, the coating entirely inclosing the rod.

483,759. Electrical Heater; Arthur E. Appleyard, Boston, Mass. Application filed Dec. 28, 1891. An electrical heating apparatus comprising in its construction a water-tight casing lined with insulating material not affected by heat and an electrical resistance composed of a flat or ribbon-like strip within the casing and in direct contact with the insulating material, the sides of the strip being presented to the insulated material.

483,761. Closed Conduit for Electric Railways; William G. Creighton, Norwood Park, Ill. Application filed Feb. 6, 1892. A combined tube and rail provided with an angular slot for the passage of the traveling contact, and a slot or the slot-closer and a depending flange between the two with a lug to limit the downward movement of the latter.

483,768. Police-Telegraph System; Charles A. Rolfe, Chicago, Ill. Application filed May 6, 1892. The combination of shunt-contacts, the rotary cam provided with stops and arranged for separating the shunt-contacts, and the shunt relay having its armature arranged to engage one of the cam stops when said armature is in its normal position, and to stand in the path of the remaining cam-stop, so as to engage the same when the armature is attracted by the relay magnet.

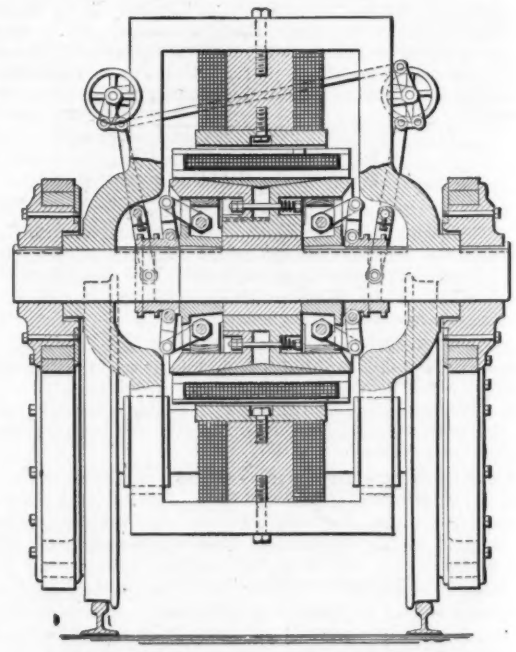
483,771. Insulator; Albert P. Seymour, Syracuse, N. Y. Application filed March 5, 1892. A block insulator provided at the end that engages the surface of the support with a number of bearing studs projecting directly from the body thereof at a number of points between the edge and the central perforation of the fastening screw.

483,782. Thermo-Electric Battery; Paul Giraud, Chantilly, France. Application filed Aug. 1, 1891. An electrode for a thermo-electric battery, composed of antimony, zinc, cadmium, silicium, copper, and tin in proper proportions.

483,806. Insulated Rivet; William S. Hull, Sheffield, Ala. Application filed May 2, 1892. A rivet provided with a non-conducting sleeve, jacket, or covering set within the body of the rivet.

483,816. Alternate Current Motor; William Stanley, Jr., and John F. Kelly, Pittsfield, Mass. Application filed March 10, 1892. The combination, with an alternating current motor, of a condenser or its described equivalent in a shunt to the motor and of a capacity or value capable of neutralizing the self-induction of the motor with which it is associated.

483,822. Electric Locomotive; Thomas L. Willson, Brooklyn, N. Y. Application filed Aug. 25, 1891. The combination of an armature shaft geared to the driving wheels, an armature mounted loosely on the shaft and having a recessed hub, and a friction-clutch having friction shoes connected to the shaft and engaging in the recess of the hub. (See illustration.)



No. 483,822.—Electric Locomotive.

483,844. Burglar Alarm Contact; Nevil Monroe Hopkins, Washington, D. C. Application filed May 9, 1892. The combination, in a burglar alarm system, of a rod or lever circuit, a tension device forming part of the local circuit, a trip mechanism, and a main line circuit, the main line circuit being adapted to be closed by the breaking of the local circuit.

483,856. Electric Railway; William G. Murphy, Jr., Marysville, Cal. Application filed Sept. 30, 1891. A connector formed of two sliding bars, each carrying a grooved roller car contacting with the cable, one bar being adapted to raise the cable and the other to depress it.

483,862. Electric Switch; Henry T. Paiste, West Chester, Pa. Application filed May 14, 1891. The combination of shoulders or stops with a rotary switch-bar, a shaft having an eccentric, a spring connecting the shaft and switch-bar, and a catch connected with the switch bar to rotate therewith, but free to have a lateral motion independently thereof, the catch being acted on by the eccentric to cause it to engage with and be disengaged from the shoulders or stops as the shaft is rotated.

483,940. Electric Heater; Fred. B. Perkins and Chas. S. Jones, Toledo, O. Application filed April 1, 1892. A cylinder formed with longitudinal grooves on each side and conducting wires wound longitudinally on the cylinder and lying in these grooves and insulated by means of a plastic material compacted on the wire and adhering to the cylinder.

483,974. Holder for Incandescent Lamps; Edwin Percival Allam, Romford, England. Application filed Oct. 27, 1891. The combination, with a base of non-conducting material and two contact pieces secured therein, of two contact screws having their heads let into the base and a removable disc of non-conducting material clamped on the top of the base and provided with a hole through which the wires pass to the screws.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.